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OF THE
PUNCHED CARD METHOD
IN
COLLEGES AND UNIVERSITIES

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EDITED BY
G. W. BAEHNE

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FOREWORD

THE appearance of a volume such as this, pointing out specific methods for the utilization of punched card equipment, will be welcomed by the increasing number of educational institutions which are undertaking to facilitate both their routine recording processes and their work in research. At a first glance these two uses of the punched card machines seem widely separated. Recording and accounting, necessary and essential functions in all educational institutions if the sinews of war are to be supplied to the educational world, are nevertheless often viewed as purely matters of routine which the average educator would dispense with if he dared. On the other hand, his research and instruction have been viewed as almost entirely in the realm of language and thought and not in any sense as matters which can be facilitated by machines. To be sure, the mechanically inclined mathematician and the engineer have developed many ingenious devices which aid their calculations. In recent years they have even considered it desirable to instruct students in the use of such machinery and to urge them to substitute mechanical methods for laborious hand calculations. Nevertheless it is only recently that recognition of the laboratory, and of technical methods, has gained any foothold in many of the subjects taught in our educational institutions.

We are even now only faintly aware of the diminishing differences between the costs of instruction and research in the so-called laboratory sciences and in the social sciences and humanities. Many who are thoroughly convinced of the possibilities of research in these latter fields, and as a matter of fact have themselves engaged in such research for many years, are still unconvinced of the need for mechanical appliances of the type here discussed. It also comes as a shock to those who supply the financial needs of educational institutions to realize that the expense in laboratory facilities and mechanical contrivances which is being requested by these fields is only the forerunner of increasing requests of a similar type. They have fondly hoped that the expensive laboratory demanding equipment of all types would remain limited to mechanics and physical sciences in which they first began.

The social scientist now realizes that many of the problems which he undertakes to solve can be managed on a machine basis whereas in earlier years he would not have undertaken them at all because of the enormous amount of hand labor involved. It is true that in none of the fields of research have machines reduced the necessity for clear thinking and accurate observations, but they have, notwithstanding, enormously reduced the labor of putting data in shape for these essential processes. Mr. Baehne and his associates are to be commended for their effort to place before research workers and the in-

structing staff of our educational institutions the experience of pioneers in the use of the Punched Card Method. It is to be hoped that the appearance of this book will encourage many others to experiment with these and similar machines in order that greater and greater use may be made of such excellent devices.

C. S. YOAKUM.

Ann Arbor, Michigan.
January 15, 1935.

EDITOR'S PREFACE

FOR many years the Punched Card Method, also variously known as the *Hollerith, Tabulating Machine,* or *Electric Accounting Machine* Method, has played an important albeit silent part in the work of leading universities.

Developed originally almost fifty years ago for tabulating census data, its application to other fields was rapid and eminently successful. Commerce and Industry, Institutions and Governments throughout the world have found in it a matchless tool for an almost infinite variety of statistical and accounting tasks.

It is not always clear that mechanical calculation has become as utilitarian and necessary to educational institutions as mathematics and that its development is, in fact, the natural outgrowth of the statistical method of approach to modern learning.

We have only to examine the last census in support of the first of these contentions. In the past three decades of this century the population of the United States increased approximately sixty-one per cent. During the same period the number of students enrolled in our colleges and universities grew 850 per cent, or nearly fourteen times faster than the rise in population. At present close to one million men and women are studying for degrees. Hundreds of thousands more do extension work or take casual courses in summer schools. The college has become a small city with all the problems familiar to a small city. Moreover, with decreasing income and increasing expenses balanced budgets are difficult to strike. As outworn and tedious accounting programs of another day have become impractical and ineffectual, more efficient methods of control and cost analysis have become imperative.

Obviously, then, since universities and colleges have participated in a world growth the problems raised by this expansion outside of these centers of learning are no strangers to it. Problems of group control familiar to a government or industry are just as familiar in a restricted way to a smaller body with similar aims and ideals. The economies that any social group can effect by adopting mechanical technique in management are economies a university can likewise effect by the same methods. Fundamentally, it is administration plus expansion of detail. A college dollar can be just as well or poorly spent as any other dollar.

Just as the population has grown and forced overboard the older methods of regulation, so has the scope of education expanded and radically altered the technique of scientific inquiry. The modern inquisitive trend is so entirely devoid of limitations that there is no possible way of predicting what statistical problem may be raised at any time. In the various sciences the demand now

is for knowledge and more knowledge regarding changes and trends which represent complicated and time-consuming arithmetical labor. Medicine, Law and Education, the Natural and Social Sciences, and even the Humanities all impose burdens of calculation and tabulation with absolute disrespect for the possible time involved.

This has resulted from the logical development of statistical thought. It has been gradual rather than precipitate, with its true origin in the 17th century of Galileo and Newton. However, the very modern phase has occurred within the past thirty odd years, the era of Thomson, Millikan and Einstein. Thought itself has changed. Just as in the 17th century when the statistical approach was first evolved the original mechanical calculator was invented, so, in recent years, numerous high speed calculating machines have been perfected, in common with the Punched Card Method, as the need for them became peremptory. In our day, when neat classifications are falling before the onslaught of a great curiosity about the various and detailed, rapid and accurate devices for making the requisite quantitative analyses are an absolute necessity. The machinery did not precede the trend, it did evolve as a result of a very basic need created by fundamental thought changes.

Statistical projects formerly prohibitive in time and money have suddenly become practical. No matter what the material on hand, economical surveys can be made from every pertinent point of view. The net result is that whatever it is advantageous to know can be revealed, whether that item is a manufacturing cost, a suspected cosmic variation, or a complex problem in budgetary administration.

So numerous are the uses of the Punched Card Method in colleges and universities and so great the interest shown by these institutions that the preparation of this volume was a logical development. In a way this book constitutes an act of self-defense on the part of many of its contributors, whose time has been severely taxed by trying to take care of a growing volume of inquiries concerning their experiences with this method.

Briefly, the object of this book is threefold: (1) To assist those engaged in statistical research to select methods which will lighten their burden of detail and give them more time for productive work; (2) To introduce new norms for measuring the practicability of large scale statistical studies that have not been undertaken in the past because of the prohibitive expense of hand methods, and (3) To assist university administrators to reduce the expenses and increase the efficiency of their institutions.

"How," it may be asked, "is it possible for one system to be applied efficiently to so widely different purposes?" The answer to this question must needs be found within the covers of the book itself. No few words can adequately tell what the Punched Card Method is or what it does, but the reader's attention is called to a brief summarization of the subject on pp. 4 to 8 ff.

A few remarks regarding the arrangement of the book may not be amiss. It was felt at the outset that our readers would prefer authoritative articles actually prepared by the users of the method in the various universities to a general theoretical discussion of the subject. All chapters of this book have,

therefore, been written by men of recognized position and authority, many of whom spent years in perfecting the methods here described.

The chief disadvantage of this otherwise most desirable arrangement is the fact that it has resulted in a certain amount of unavoidable duplication. While, in general, the scheme has been to separate the various applications according to the usual division of activities in universities, this has not always been possible. In those cases footnotes call attention to other parts of the book where similar applications are described.

In order to simplify the reprinting of individual parts of this volume, appendices which would normally be relegated to the end of the book have been inserted immediately following their corresponding chapters.

No attempt has been made to explain in detail the routine procedures that are used. These vary with the types of machines employed, the volume of data and other considerations and have to be worked out to fit a particular situation. The principal aim has been to show *what* the Punched Card Method can do and *why* it can do it, with the *how* delegated to a secondary place.

Users of the punched card method are naturally progressive and it may be assumed that by the time this book reaches the reader important additional applications will have been developed and improvements made in existing methods. There are still many possible uses which have never been investigated. The application of tabulating machines to new fields of work in education is a project which deserves and which will repay careful research.

Our sincere thanks are due to our contributors, who have given freely of their time and experience and have cooperated unhesitatingly in adjusting their chapters to meet the needs of the book. If others will realize that there is here presented a unique tool for effecting economies, for increasing coordination of institutional activities and for doing statistical research on a scale which seemed impossible before, the book will have served its purpose.

G. W. Baehne.

New York, January, 1935.

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PART I

Development and Principles of the Punched Card Method
(Hollerith)

PART I

Development and Principles of the Punched Card Method
(Hollerith)

By

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Development

EVEN the briefest account of man's search for some means to make arithmetical calculation "easier" must touch upon its ancient history. Remarkable as it may seem, the first mechanical calculator, knotted strings, dates back further than the Ptolemies.

From very early times the science of mathematics suffered from tedium imposed by mental calculation. The primitive Roman abacus, which stated an arithmetical problem in terms of physical counters, permitted the early mathematician to *see* his calculation while he *thought* it out. This was the first step and proved so sound that variations of the abacus are still in use in the Orient.

In the 17th century a refinement of the abacus produced Pascal's mechanical calculator. It is significant that this occurred the year Newton was born and fifty-eight years before Newton and Leibnitz published their papers on integral and differential calculus. What the Pascal calculator did, a thing the abacus did not do, was to further eliminate mental effort by producing a total after the problem had been stated on numbered discs. This was the second step and reduced the element of error in *rapid* calculation to the accurate manipulation of the number-setting discs. Like the abacus the Pascal calculator was so sound in principle that beyond perfection of detail few changes have been effected down to our day.

The third step in rapid and accurate arithmetical calculation did not occur until the early part of the 19th century. It is important to remember that this third step represented an entirely different approach to the whole problem. The principle of visualizing the calculation was dropped in so much as this necessitated a constant correct perception on the part of the operator. The arithmetical process, from statement to answer, was made mechanical and automatic. This is the basis of the Hollerith card punching system.

Babbage, influenced by a system of punched cards used in pattern loom weaving, invented the "analytical engine." All hand operations were discarded and pre-punched cards replaced the numerous finger operations. Scheutz, a Swedish printer, later introduced a refinement in the mechanical operation of the calculating machine itself. It remained for Dr. Herman Hollerith, whose system is used by the authors of this book, to perfect the inventions of Babbage and Scheutz and to make the first successful application.

During the latter half of the 19th century a pressing need was felt for some mechanical aid to expedite the complicated and Herculean labor of taking the census. Dr. Hollerith, a noted statistician, had been engaged by the United States Government as special agent during the census of 1880. At that time it was feared that the next census would, owing to population increases readily observable, be worthless by the time it could be completed. Dr. Hollerith realized that some mechanical aid would be necessary to avoid complete failure. He developed his system for transcribing the census data onto paper strips (now cards) by means of holes punched instead of numbers written. The punched holes would then actuate the automatic accounting and tabulating machinery by a very simple electromagnetic principle.

It was first tried in the tabulation of vital statistics in several states and by the Board of Health in New York City. A commission appointed by the United States Superintendent of the Census made a thorough and practical test of all systems of tabulation and reported that the Hollerith method of card punching could transcribe census records in three-fourths of the time required by other systems. As this commission further stated that the data could be tabulated eight times faster by the Hollerith Electric Counting Machines than they could by other well-known methods, the Hollerith machines were selected for the census of 1890.

This census installation attracted wide attention. About this time the Hollerith method was adopted by the government of Austria-Hungary. More significant still was the application made by Dr. Hollerith of his method to transportation and commodity statistics. This was a logical outgrowth of the successful census work, and the use at that time of the Hollerith system by the Freight Accounts Auditor of the New York Central Railroad indicated subsequent industrial and social applications. By the turn of the century, and after many improvements and refinements had been effected in the machinery, the Hollerith system was becoming fairly well known and began to be used more and more extensively.

Naturally the sum of continued improvements and increasing experience exerted a broadening influence on the entire field of statistical inquiry. As it became evident that giant surveys could be digested with the speed and precision formerly associated with only the very smallest, those engaged with the technique of research became curious about this new mechanical aid. Wherever greater knowledge was desirable, whether for the guidance of the business administrator or the scientific investigator, the machinery for fact-finding existed and could be applied.

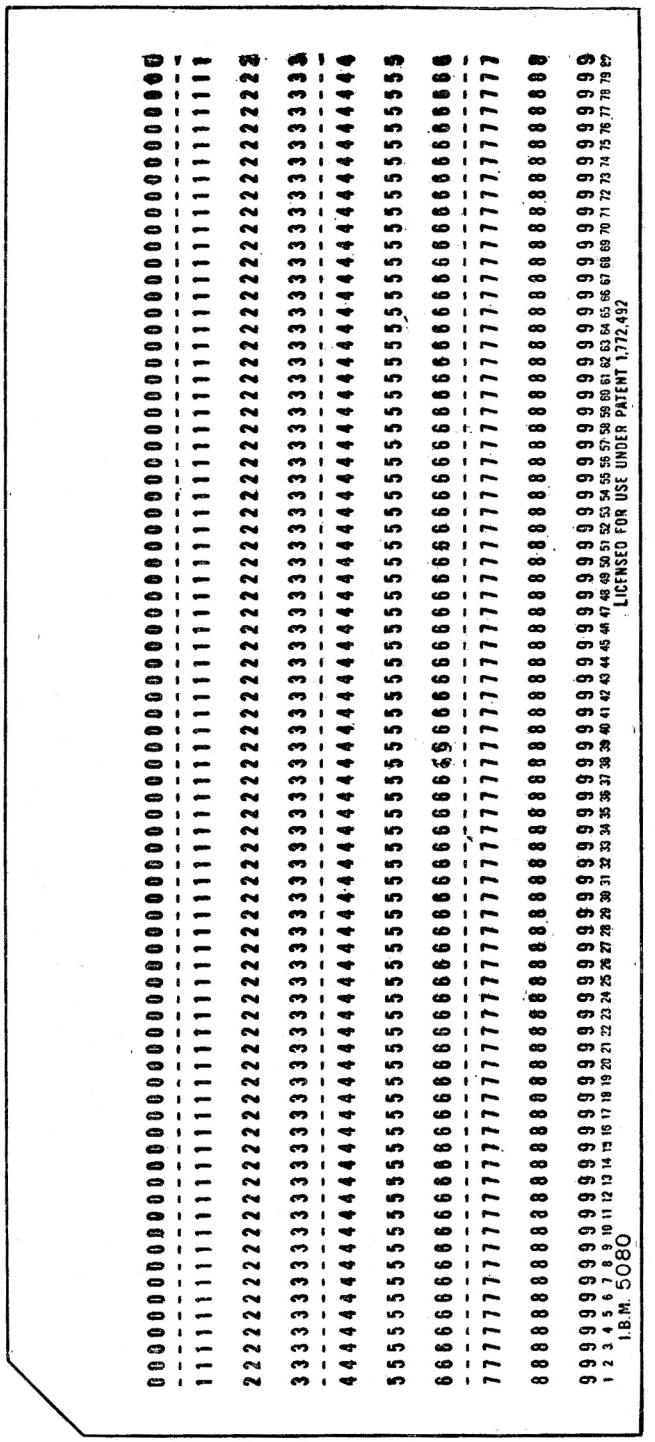


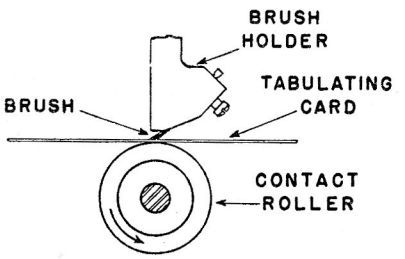
FIG. 1

A blank tabulating card; actual size

Operating Principles

The basis of the Punched Card Method is the tabulating card.* All pertinent information, originally written or typed, is transcribed from the source records into tabulating cards in the form of punched holes. The holes are punched in predetermined positions on the card, according to the information registered. These punched cards serve to actuate the various machines into which they are subsequently placed.

The automatic compilation of facts recorded in tabulating cards is performed by electricity. The passage of the perforated cards under brush contacts permits an electrical impulse to be made through the card at the position of the punched hole. This closing of an electrical circuit at a definite time and from a fixed position on the card is the basis upon which the various electrical accounting machines function.



The illustration on the preceding page, Fig. 1, is a reproduction of a tabulating card in actual size. There are eighty columns of digits across the card. Each column contains twelve punching positions. Of these, ten are indicated by the printed digits 0 to 9, which correspond to the digits of the numerical data to be punched. The 11th and 12th punching positions are at the top of the card and are not indicated by printed numerals. If the 80-column card is completely punched it contains 960 holes—80 columns of 12 positions each (Fig. 2).

Another type of card, not shown here, but referred to and illustrated frequently in other parts of this book, is known as the 45-column card because it contains 45 columns of twelve punching positions each. If fully punched this card will therefore have 540 holes. This type of card represents an earlier stage of development and as its cost is the same as that of the 80-column card it is rapidly falling into disuse.

The first step in the use of a card for a particular record is the designation of groups of columns as "fields." Each field defines a section of the card in which one particular type of information will always appear.

The illustration following on page 6, Fig. 3, shows an 80-column card partly drawn up into fields. Each field is assigned a sufficient number of columns to include the largest number of digits which it will be called upon to accommodate.

For instance, the greatest number of months is 12 (a two-digit number), therefore two columns are sufficient for recording this information. The greatest number of days in a month is thirty-one, thus this field too requires only

---

* To meet the exacting requirements of tabulating uses and assure accuracy of machine operations under all climatic conditions, extreme care is exercised in the manufacture of these cards.

Smooth surfaced quality paper of high tensile strength is subjected to an ingenious test which assures that every tabulating card is an absolute non-conductor of electricity. Uniformity of thickness is maintained within limits of .0005".

Similarly exacting standards are followed in the printing of these cards which is done by special cylindrical electrotypes to assure perfect registration and legibility. The result is a card of a very high degree of permanency and reliability.

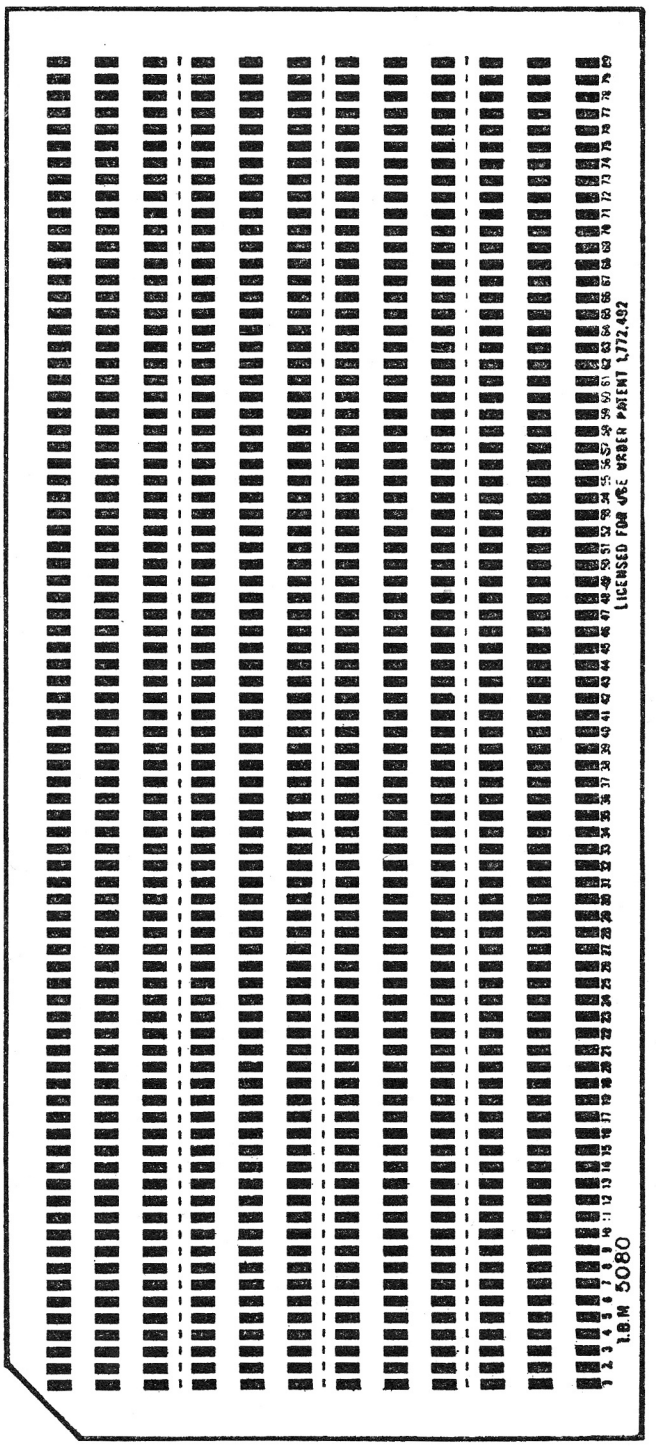


FIG. 2

An 80 col. tabulating card, fully punched, actual size.

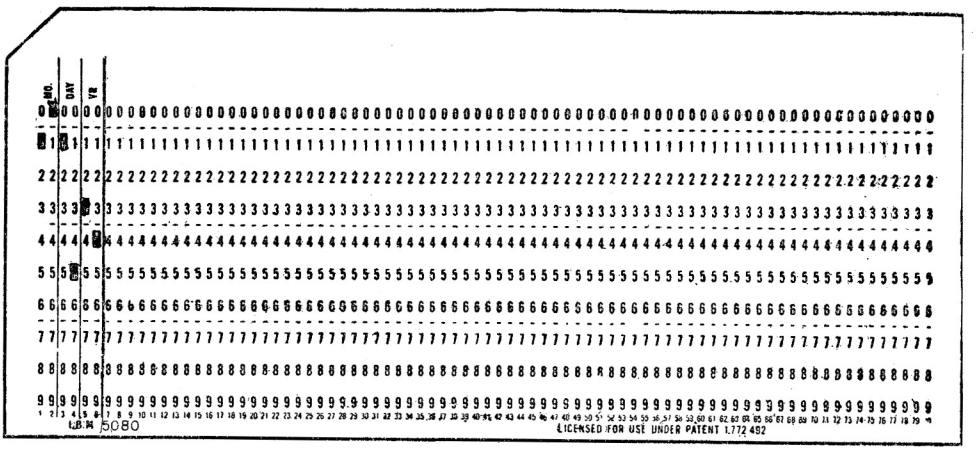


FIG. 3

two columns. The year is indicated by the last two digits, making two more columns necessary, etc.

Fig. 4 illustrates another 80-column card completely laid out for a specific job, in this instance a complex legal study.

At this point it is obvious that all pertinent information must be registered in the card in the form of punched holes. The perforation of these holes is a simple matter. The digits of the numbers to be transcribed correspond to the

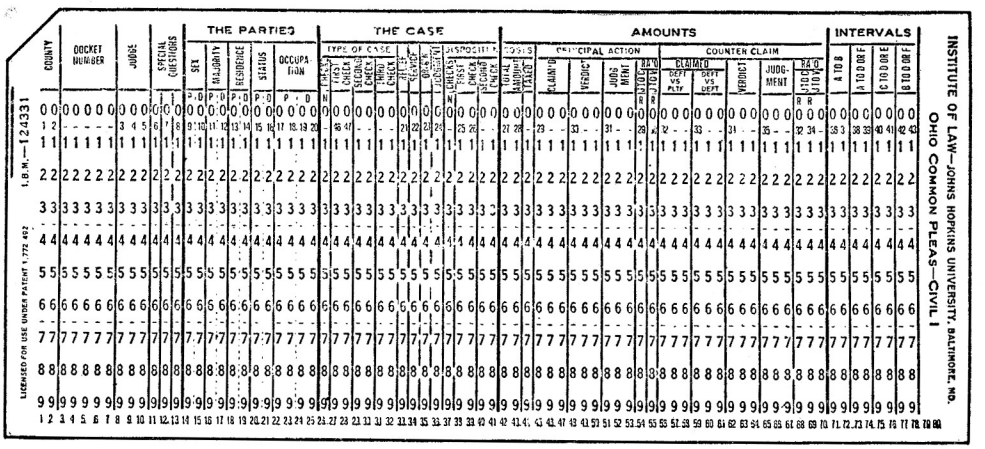
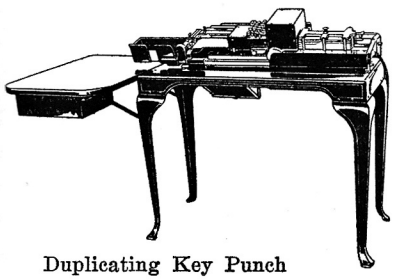


FIG. 4

digits printed on the card. Thus, to show the date October 15, 1934, on the card illustrated above, Fig. 3, the card is perforated as follows: 10-15-34. Descriptive information, such as the names of persons or products is generally coded numerically, although as subsequently explained, there are machines that are able to identify and print alphabetic characters from punched holes. Reports prepared on the numerical tabulator show all data in figure form while

the alphabetic type of machine gives both descriptive (alphabetic) and numerical data, no coding being necessary.

The many card forms appearing in other sections of this book illustrate the principles of field design and punching procedure, while numerous reports prepared on both the numerical and the alphabetic machines show clearly the difference in result between the two types of devices.

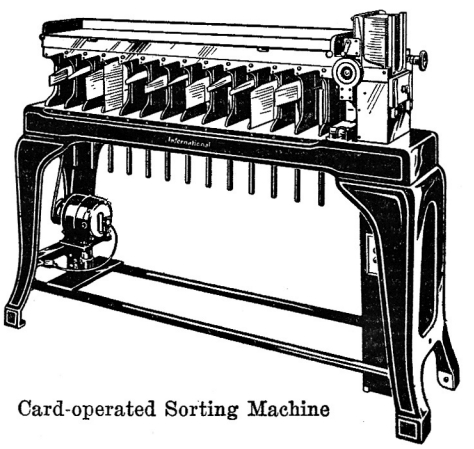


Duplicating Key Punch

Tabulating cards are perforated by means of an electric punching machine. The punch designed for the numerical system has a keyboard consisting of twelve keys, one for each punching position of a column. As a key is depressed a hole is cut and the card advanced automatically to the next column to be punched. The automatic features of the machine and the simplicity of the keyboard make the transcription of written data into punched hole form easy, rapid and efficient. (See also Fig. 8, page 12.)

When punching has been completed, the cards are usually in miscellaneous order. The next step is to arrange them in sequence by some desired classification—that is, to group them according to some information which is punched in them. The Card-operated Sorting Machine is used for this purpose.

The operation of the Electric Sorting Machine is based on the position of the punched hole in a vertical column of the card. As the cards pass through the machine a brush contact is made through the hole causing an electrical circuit to be closed. This momentary circuit causes the card to be directed to a receiving pocket which corresponds to the position of the punched hole. For example, a card punched "9" in the column under consideration is directed to the 9 pocket, a card punched "6" in the same column is directed to the 6 pocket, etc. (For further description see Figs. 5, 17 and 18, pp. 10 and 16.)

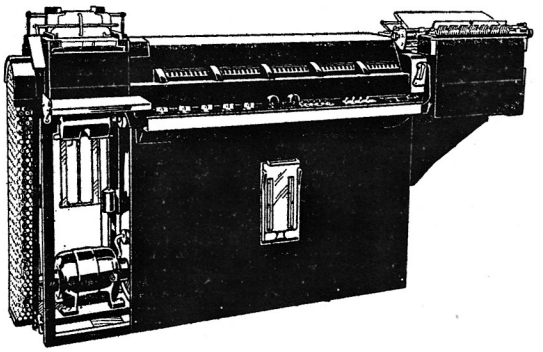


Card-operated Sorting Machine

The automatic sort is made on one column at a time. It is apparent, therefore, that to arrange a group of cards in numerical sequence according to the data punched in a three-column field, the group is passed through the sorting machine three times. The sort is made first on the units column, then on the tens column and finally on the hundreds column. The Card-operated Sorting Machine is entirely automatic and operates at a speed of 400 cards per minute.

The third step in the Punched Card Method is the automatic compilation of the data into printed reports. This is accomplished by the Electric Tabulating Machine which is a combined adding, subtracting and printing machine.

(See Figs. 19 and 20, page 17). Punched cards passing through this machine actuate the various adding counters and printing mechanisms—again by means of electrical contacts. Each Electric Tabulating Machine is so designed that it provides complete flexibility of arrangement of the compiled and printed data on the report form. The machine is entirely automatic, operates at a speed of 150 cards per minute, and is so arranged that summary cards can be punched simultaneously with the printing of reports. Its various features are best demonstrated by the results produced. Many of these are shown in the form of printed reports appearing in other sections of this book.



Electric Tabulating and Accounting Machine

In addition to the three basic machines discussed above, many auxiliary machines and devices have been developed for the purpose of accomplishing automatically the supplementary tasks related to the classifying, compiling and printing of data. All the machines follow the same general principles which have been previously described. In order to aid the proper understanding of the following chapters, the machines discussed above as well as some of the auxiliary machines and devices are illustrated and explained in the appendix to Part I (pp. 10 to 20).

APPENDIX TO PART I

Development and Principles of the Punched Card Method

(Hollerith)

DESCRIPTIONS AND ILLUSTRATIONS OF VARIOUS TABULATING MACHINES AND SPECIAL DEVICES

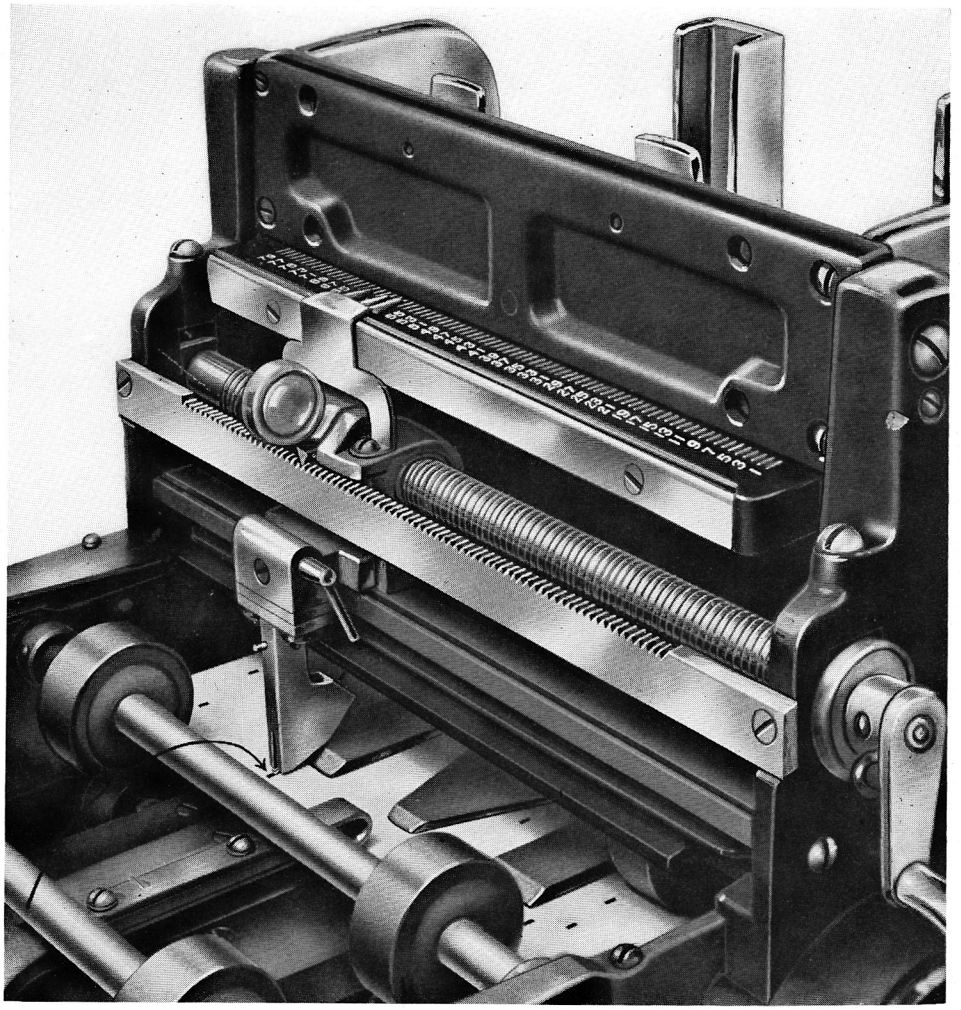


FIG. 5

THE OPERATING PRINCIPLE OF THE PUNCHED CARD METHOD (HOLLERITH PATENTS)

A tabulating card, acting as an insulator, passes between a wire brush and a brass roller.* A hole punched into the card causes the brush and the brass plate to make contact (see arrow Fig. 5) and closes an electric circuit which, in turn, actuates an electro-magnet. In the case of the sorting machine (illustrated) this magnet opens a chute along which the card slides until it falls into the proper receptacle.

In the tabulating and accounting machines a row of brushes, corresponding to the columns of the card, takes the place of the single brush shown above. The contacts, similarly made, energize counters or print banks.

In either case, the classification to be made, the values to be added or subtracted, or the letters to be printed, are determined by the position of the card at the time the contact is made.

* The contact roller is not visible here, being completely covered by the tabulating card (see page 4).

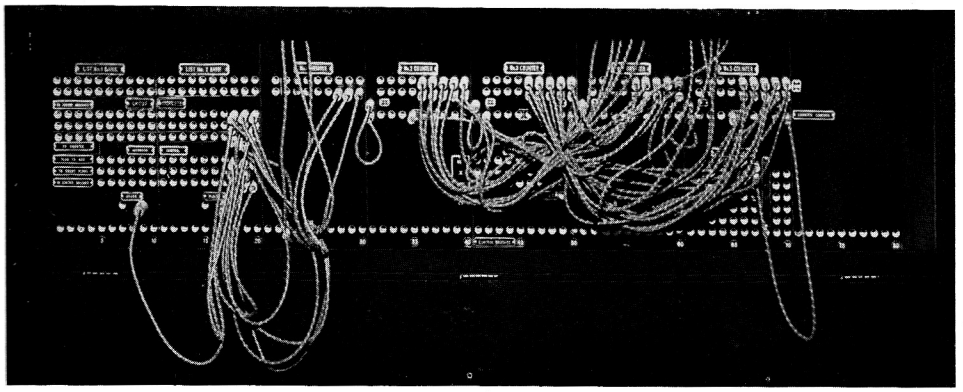


FIG. 6

A TYPICAL TABULATING AND ACCOUNTING MACHINE PLUGBOARD FOR MANUAL WIRING

Because they are operated by electricity rather than by any mechanical means, flexibility is an inherent feature of all electric tabulating and accounting machines. To attain this flexibility the more complex machines employ a plugboard which is similar in principle to a telephone switchboard.

In the plugboard illustrated (Fig. 6) there are two rows of numbered sockets corresponding to the 80 columns on the card (top row of sockets not visible in illustration). After the information to be added or indicated has been determined for any given report, plug wires are inserted to connect the sockets corresponding to the tabulating card fields in which the data are punched, with any desired adding counter or list bank.

By utilizing the second row of sockets and an automatic control device and by having several counters to carry sub-totals, intermediate totals and grand totals, the machine will automatically sense changes in classification, print totals and proceed with the tabulation of the next classification.

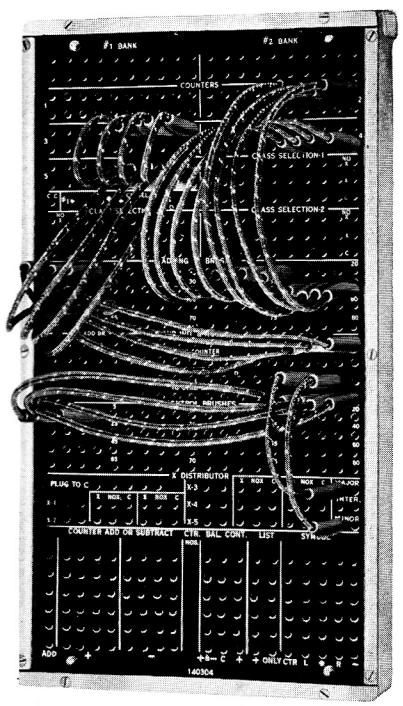


FIG 7

Most machines are equipped with various other devices for selecting specific information and rejecting other, for counting the cards going through, for transferring totals, etc. (See Special Device Section pp. 18 and 19.

AUTOMATIC PLUGBOARD ASSEMBLY

The manually operated plugboard illustrated in Fig. 6 is being rapidly superseded by the automatic plugboard assembly (see Fig. 7) which enables a complete change of plugging arrangement to be made in less than a minute.

The use of this assembly speeds production since the only requirement in changing from one form of report to another is the insertion of a pre-plugged Set-up Slide in the machine at the completion of the first report. A Fixed Set-up (permanently wired) is obtainable for routine reports, one for each form or for each of those most frequently used. Another type is the Manual Set-up which can be wired for any report form and kept ready for use.

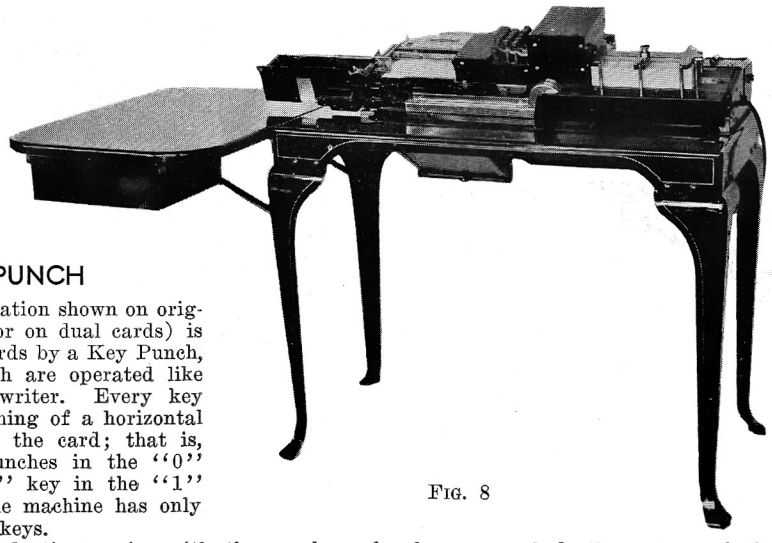


FIG. 8

KEY PUNCH

Original information shown on original documents (or on dual cards) is punched in the cards by a Key Punch, the keys of which are operated like those of a typewriter. Every key governs the punching of a horizontal line of digits on the card; that is, the "0" key punches in the "0" position, the "1" key in the "1" position, etc. The machine has only twelve punching keys.

Punching production varies with the number of columns punched, the nature of the original information, and the ability of the operator.

Different models are available: one which is operated entirely by hand; another whose cutting dies are electrically actuated; a third, illustrated here (Fig. 8), is further equipped with automatic card feeding and ejecting devices. It also has a duplicating feature which enables the machine to be used as an automatic coding device. Codes are pre-punched in master cards; the proper master card is positioned in the machine and during operation the code is automatically punched in detail cards. This process eliminates a second coding operation, code checking, individual code punching, and checking of the code punching.

All models of punches may be equipped with "Skip Bars," also known as "X" bars, which fulfill a function similar to that of the tabulating device on a typewriter. Predetermined groups of columns may be skipped either in punching or duplicating. Depending upon the type of punch the skipping process may be fully automatic or semi-automatic. In the latter case the depression of the "X" key is necessary.

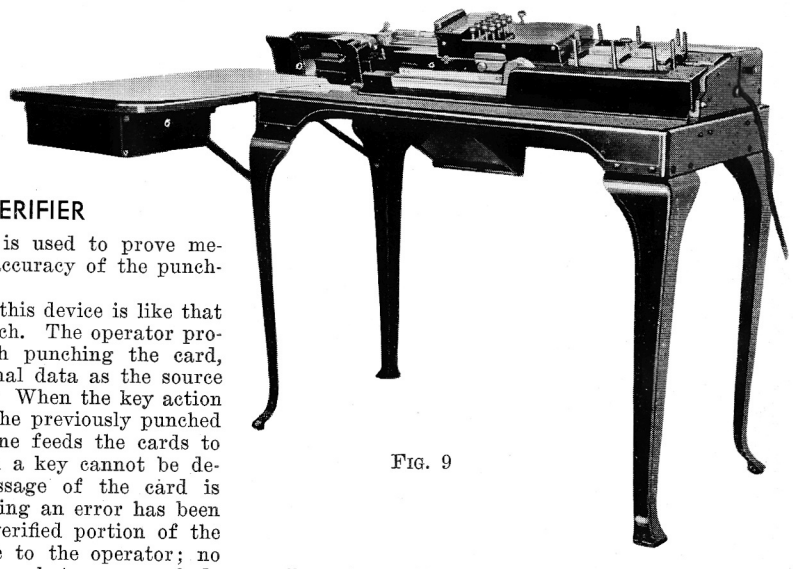


FIG. 9

VERIFIER

The Verifier is used to prove mechanically the accuracy of the punching (Fig. 9).

Operation of this device is like that of the Key Punch. The operator proceeds as though punching the card, using the original data as the source of information. When the key action coincides with the previously punched holes the machine feeds the cards to the left. When a key cannot be depressed the passage of the card is stopped, signifying an error has been made. The unverified portion of the card is invisible to the operator; no suggestion as to what was punched can affect the verification, which therefore is positive instead of negative.

Where a limited number of cards are to be verified the Mechanical Verifier, a compact device requiring no electric current, may be used. Above is shown the Motor Drive model.

FIG. 10

ALPHABETIC PRINTING PUNCH

The Alphabetic Printing Punch is used to punch both alphabetic and numerical data into a tabulating card so that completely spelled names, descriptive words, etc., together with numbers, can subsequently be printed by an Alphabetic Accounting Machine.

This punch is equipped with a typewriter keyboard (Fig. 10). The depression of a key causes the machine to punch the card and simultaneously print the corresponding letter or figure at the top of the card above the column punched. Checking, filing and reference operations are thereby greatly facilitated.

The familiar typewriter tabular inserts control the skipping of the card to the proper columns to be punched. The cards are automatically fed and ejected.

Another model of the Alphabetic Printing Punch is equipped with a duplicating feature by means of which information common to more than one card can be automatically printed as well as punched on successive cards.

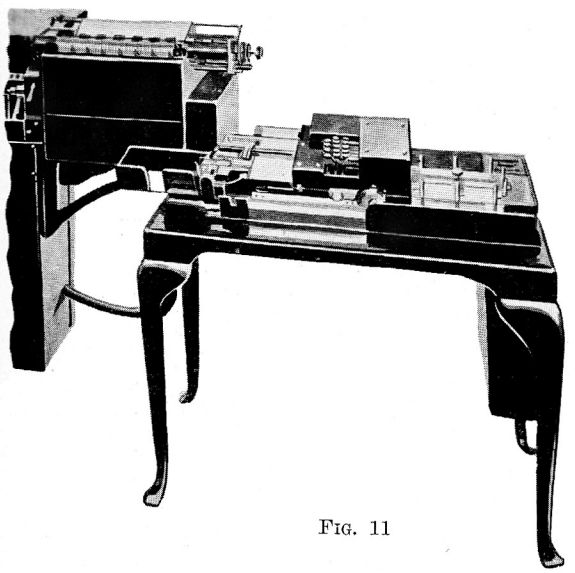


FIG. 11

AUTOMATIC SUMMARY PUNCH

The Automatic Summary Punch (Fig. 11) is used to punch summary or new balance cards during the tabulating process of the accounting machine to which it is attached. The accounting machine stops at every control change; the information appearing in its counters is then electrically transmitted to the Summary Punch and by it recorded on tabulating cards.

In addition to recording classifications and totals received by electrical impulse from the accounting machine, the Summary Punch can also record common data received by electrical impulse from a pre-punched card in the master card rack. It can be converted into a Motor Drive Duplicating Key Punch simply by throwing a switch.

The Automatic Summary Punch provides an exceptionally fast method of obtaining a balance-forward.

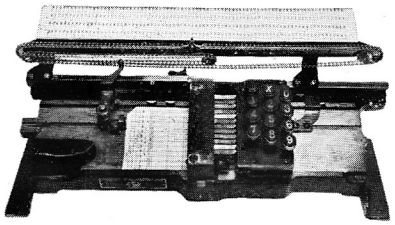


FIG. 12

MANUAL CODE PUNCH

The Manual Code Punch (Fig. 12) is applicable where the original information is not in sequence. In certain types of coding it may be necessary to punch a hole in, for example, column 30, the next one in column 68, the next one in column 6, etc. On the automatic punches such going back and forth causes unnecessary waste of time.

This device is also particularly appropriate where it is frequently desired to punch a large number of holes in each column.

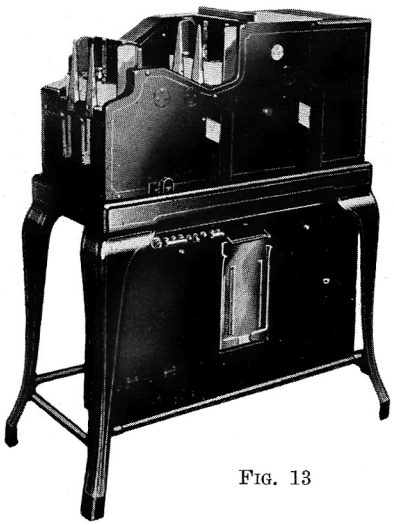


FIG. 13

AUTOMATIC REPRODUCING PUNCH

This machine is used to reproduce in a set of cards the information punched in another set. All or any portion of either numerical or alphabetic data punched in a card may be reproduced in another card in any sequence desired (Fig. 13).

It is also possible to gang punch in any number of detail cards the information punched in a master card. Both reproducing and gang punching may be done simultaneously; that is, while information is being reproduced additional data may be gang punched in the same cards.

The machine punches 100 cards a minute for all work regardless of the number of holes to be punched.

Another model is equipped to compare the holes punched in the second card with the ones in the original. In this operation, however, it is at present limited to the checking of 40 columns of the card at one time.

Both models are equipped with Automatic Plugboards.

FIG. 14

GANG PUNCH

Sometimes it is necessary that many cards be punched in identically the same manner, either wholly or in part. A Gang Punch is then used to expedite the work (Fig. 14).

Above is shown the Motor Drive Gang Punch. A master card—sometimes called a pattern card—when placed on the set-up plate of this device automatically adjusts the punching mechanism to the setting required. The set-up also can be accomplished manually.

The Motor Drive Gang Punch can be equipped with a numbering device which prints numbers consecutively or prints the same number repeatedly on the face of the card at the time of punching. An additional feature is a dial which, when set, automatically stops the machine when the desired number of cards has been punched.

A manually operated lever set Gang Punch is also made.

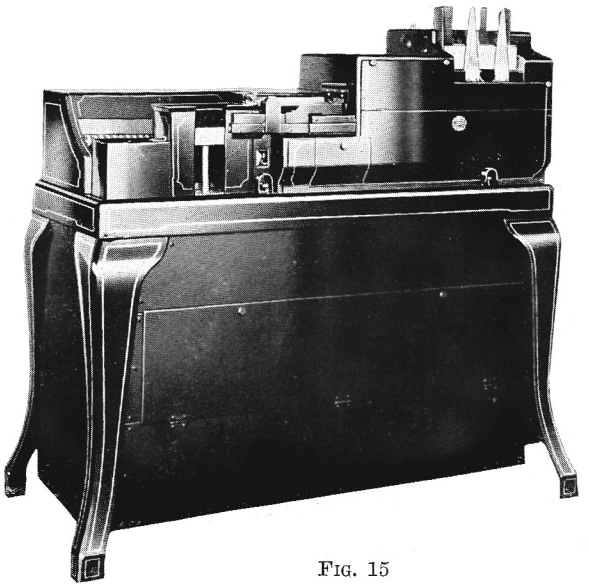


FIG. 15

AUTOMATIC MULTIPLYING PUNCH

This machine multiplies with almost lightning speed any two amounts punched in tabulating cards, adjusts the product to the nearest whole number, records the product on the card from which the factors were taken, and accumulates totals. It can also be made to cross-add and cross-subtract while multiplying, under which condition it punches the total of the cross addition or the net total (Fig. 15).

Since division of one number by another can be converted into a product by using the reciprocal of the divisor as a multiplying factor, the machine is also very useful where a common divisor is used in a number of similar calculations.

The factors may be such items as Quantity times Unit Price, Hours times Hourly Rate, etc. Either factor can contain as many as eight digits. One factor can be taken from a preceding master card and used as a common multiplier for succeeding detail cards.

Calculating and punching are accomplished at high speed—from 740 multiplications per hour for 8-digit multipliers up to 1500 per hour for 3-digit multipliers.

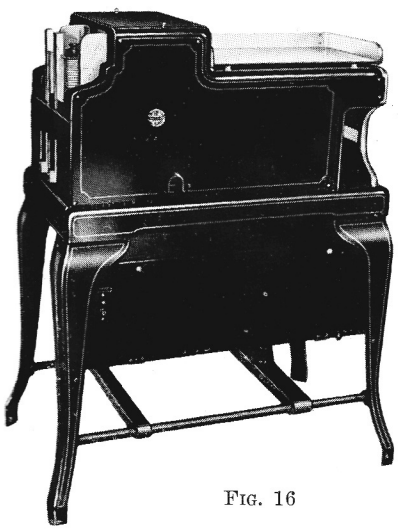


FIG. 16

AUTOMATIC INTERPRETER

Although the practiced eye can quickly read the numerals represented by the holes punched in tabulating cards, it is often desirable, for greater ease of reading in checking, filing, selection and reference operations, to have these coded figures translated and printed on the cards. The Automatic Interpreter is used for the purpose in numerical work (Fig. 16).

The printed information can be shown anywhere along the top of the card. Data punched in any 45 columns of the card may be interpreted. The translating and printing are done at the rate of 4,500 cards per hour.

Another model which is a combination check writer, check protector, and interpreter, is also provided in the above capacities and speeds.

In cases where an Alphabetic Printing Punch (see Fig. 10) is used, the use of a separate interpreter is, of course, unnecessary.

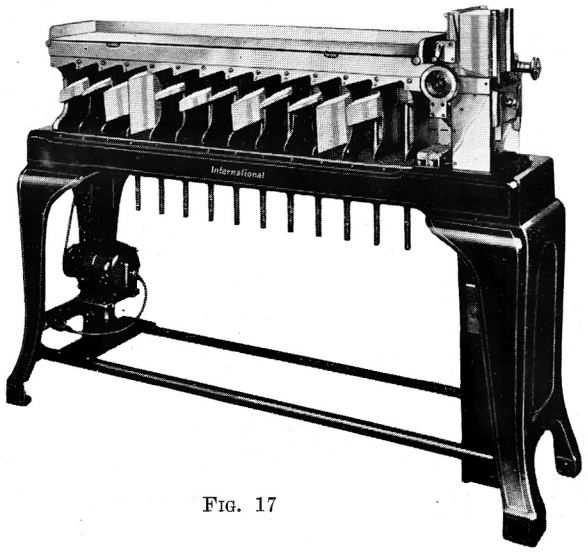


FIG. 17

ELECTRIC CARD-OPERATED SORTING MACHINE

This machine automatically groups all cards of common classification and at the same time arranges the classifications in the sequence desired (Fig. 17). By means of a commutator switch any specific classification may be selected without disturbing the sequence of the other cards in the pack.

The operating speed is about 400 cards per minute per column. The usual procedure is to arrange the cards first in the "unit" order. While in this sequence they are next arranged in the "tens" order, then in the "hundreds," etc.

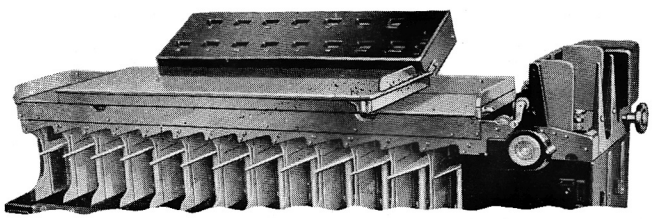


FIG. 18 (Top only)

ELECTRIC CARD-OPERATED COUNTING SORTER

In cases where a tabulating card represents a unit, as in vital statistics and unit inventory control, it becomes necessary to provide a rapid means of counting and classifying simultaneously. This machine accomplishes such results. It also operates as a regular sorter without counting, or as a counting device without sorting. The speed of this machine is 400 cards a minute when counting or sorting or doing both.

The counting mechanism is equipped with fifteen adding counters, one for each of the twelve conditions that can be recorded in a column, one for unpunched cards, one for subtotals, and one for grand totals (Fig. 18).

The visible dials are located on top behind a reading board. This arrangement permits the figures in the counters to be easily read and transcribed by the operator.

Another model of the counting sorter is equipped with one, two, or three counting and printing units, each having fifteen counters, thus permitting simultaneous counting of three columns. It sorts, however, in only one column at a time.

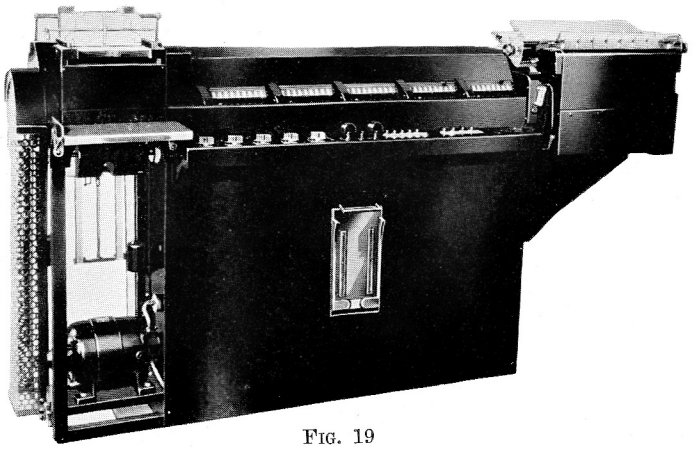


FIG. 19

DIRECT SUBTRACTION ACCOUNTING MACHINE (TYPE 3-S)

The Direct Subtraction Tabulating Accounting Machine, Type 3-S, is a multiple subtracting, adding, classifying, and printing machine which automatically produces complete printed reports from punched tabulating cards. It prints classifications, lists details, computes and prints totals, grand totals and net balances (Fig. 19).

An automatic control causes the machine to stop at the completion of each data group; the total and the group indication are recorded, then the machine clears itself and starts on the next group. An Automatic Plugboard (see Fig. 7) eliminates the necessity of plugging the machine just before printing the reports.

This type of accounting machine is furnished in three models of various printing capacities–4, 5 and 7 printing banks–all of which list from 75 to 120 cards a minute and tabulate from 75 to 150 cards a minute. It may be equipped with a summary punch (See Fig. 11).

Other tabulating machines in various capacities are available without printing mechanisms.

ALPHABETIC DIRECT SUBTRACTION ACCOUNTING MACHINE

This accounting machine (Fig. 20) is employed when it is desired to show names, addresses, descriptions, etc., printed in full on finished reports, thereby eliminating the use of codes. The alphabetic feature supplements the ability of the machine to add and subtract and to compute and print totals, grand totals and net balances. This machine, too, is equipped with an automatic control feature, (see above) and an automatic plugboard.

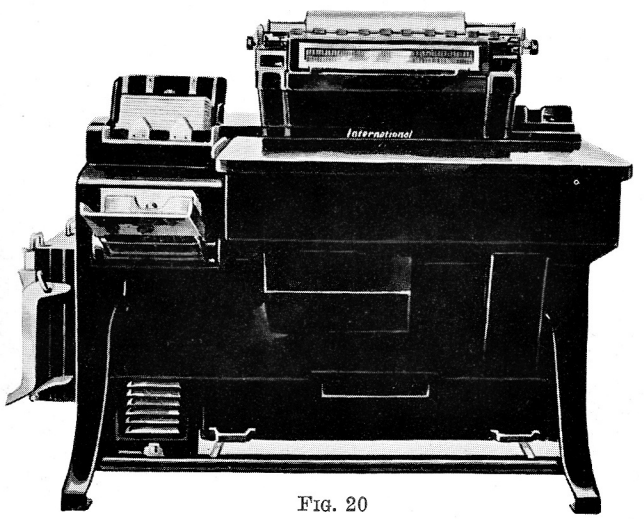


FIG. 20

Two continuous type sections have eighty-eight printing positions. The alphabetic type section can be used to list or indicate both alphabetic and numerical data and to compute and print balances and totals, an arrangement which gives great flexibility in combining alphabetic and numerical information.

The operating speed of the machine is 80 cards per minute when listing and 150 cards per minute when tabulating.

SPECIAL DEVICES

CARD MATCHING DEVICE

This is another attachment for the sorting machines. It is used to select matched cards from a group of cards by means of contrasting corner cuts. Cards having a corner cut are sorted into the 12 pocket. Square cornered cards are sorted into the 12 pocket only when they follow cards with a corner cut, but are rejected when they follow other square cornered cards.

CLASS SELECTION DEVICE

Class selection, a standard feature on all printing tabulators, greatly increases the flexibility of the machine in translating the punched holes into accumulated totals or printed reports. By use of this feature, heterogeneous data punched in a common field on the tabulating cards may be separated automatically into the various classifications on the finished report. Conversely, data punched in different fields of the cards may be grouped into a common total on the finished report. Likewise, the class selector may be used to cause certain data punched in the common field to be added to and other data in the common field to be eliminated from the accumulated totals and printed reports.

COLLATING DEVICE

This device may be installed on the Electric Card-Operated Sorting Machine. It will prepare sets of cards without requiring any identifying punch. A number of cards of each kind exactly equal to the number of sets required are placed in the hopper of the sorting machine. The sorting brush is raised so that it does not touch the cards. The collating device switch is then turned on which causes the chutes to the sorter pockets to open in rotation so that one card of each kind is distributed to each pocket.

CONSECUTIVE NUMBER CONTROL DEVICE

This device causes the electric accounting machine to indicate those numbers which are missing from a consecutive list by printing a symbol opposite the first line after the break in sequence.

COUNTER CARRY OVER DEVICE

The counter carry over device is used to secure additional adding and accumulating capacity by providing a carry over from the eighth position of one counter to the units position of another.

DECIMAL ACCUMULATING DEVICE

This may be installed on the Multiplying Punch. Its purpose is to accumulate unused decimals of products and throw them into a product for punching every time the accumulation forms a new significant unit. Thus it is possible to arrive at a group product total which is accurate to within one-half of one unit of the right hand significant digit.

GROUP SORTING DEVICE

This is an attachment for sorting machines which enables the sorting of an entire group of cards to be controlled by the punching in a "leader" master card which precedes the group irrespective of the punching of the detail cards.

PRE-SET SELECTOR

This device is for installation on tabulating and accounting machines to cause these machines to function only when cards bearing certain predetermined numbers pass the brush, all other cards being ignored. The device may be set for any number from one to six digits in size by means of six dials.

SPLIT COLUMN DEVICE

This device is employed where it is necessary to use two parts of a single column of a card for different purposes. It causes the machine to operate in exactly the same way as it would if entirely separate columns were used.

TOTAL TRANSFER DEVICE

This device provides for the printing of totals in a print bank other than that which is normally associated with the counter in which the total is accumulated.

UNIVERSAL AUTOMATIC CARRIAGE

This device may be substituted for the standard carriage on Electric Accounting Machines. It makes the printing of continuous forms such as invoices, statements, etc. fully automatic. Certain parts of the form such as title, first line, etc. may be skipped at will. Where a second sheet is necessary this device automatically provides for the proper spacing.

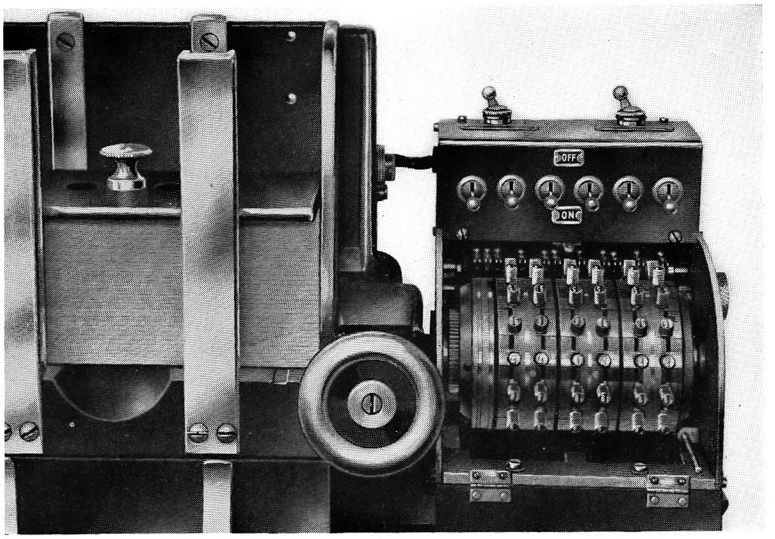


FIG. 21

MULTIPLE COLUMN SELECTION DEVICE

The Multiple Column Selection Device (Fig. 21) is a unit which may be readily installed on the Card-Operated Counting Sorter. In its standard form this device will select all cards of a pre-determined number (ranging from 1 to 6 consecutive digits) from a stack of cards without disturbing the original sequence of the cards.

There are obtainable special models of this device which permit the simultaneous selection of up to 18 digits, regardless of sequence.

While its operation is simplest if only a single hole is punched in each of the columns of the cards to be selected, it is feasible to select cards that have any number of holes punched into each column, provided only that this number is constant for all the cards to be run through the machine.

The device is operated by turning contact buttons numbered to designate each position on the card in each row and normally set so that the number on the bottom reads upside-down. In the illustration the device is set up to select all cards having the numbers 6, 5, 7, 6, 6, 5 punched in the columns that are being sorted. A special multiple brush holder with six brushes is supplied in the standard device to replace the regular sorting brush holder

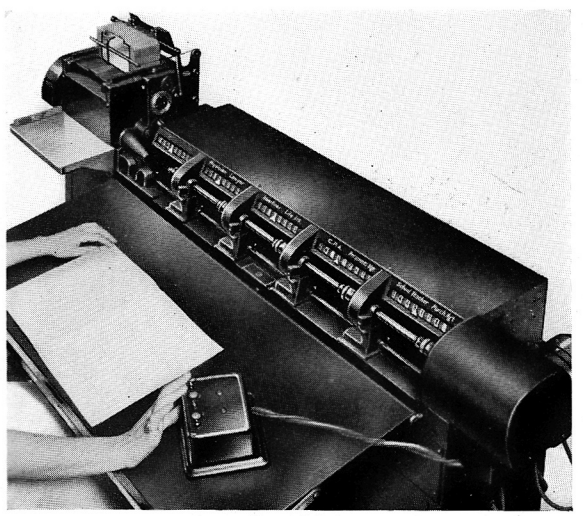


FIG. 22

TEST SCORING DEVICE

This device can be installed on any tabulating or printing machine equipped with automatic control. It greatly facilitates the scoring of vocational interest tests of the Strong type and of certain types of intelligence and similar tests.

It consists of a three-key control box which is set on the reading board of the tabulating machine which is connected by means of a cable with three-field selection relays. The depression of a key actuates the corresponding relay which, in turn, selects from a prepunched card the proper score for the answer given by the student. A more detailed description will be found on pages 228 and 229.

OTHER SPECIAL DEVICES

Numerous other devices have been developed for particular purposes. The manufacturers* have expressed their willingness to answer promptly pertinent inquiries and such correspondence should be addressed to them.

*International Business Machines Corp., Tabulating Machine Division, 270 Broadway, New York, N.Y.

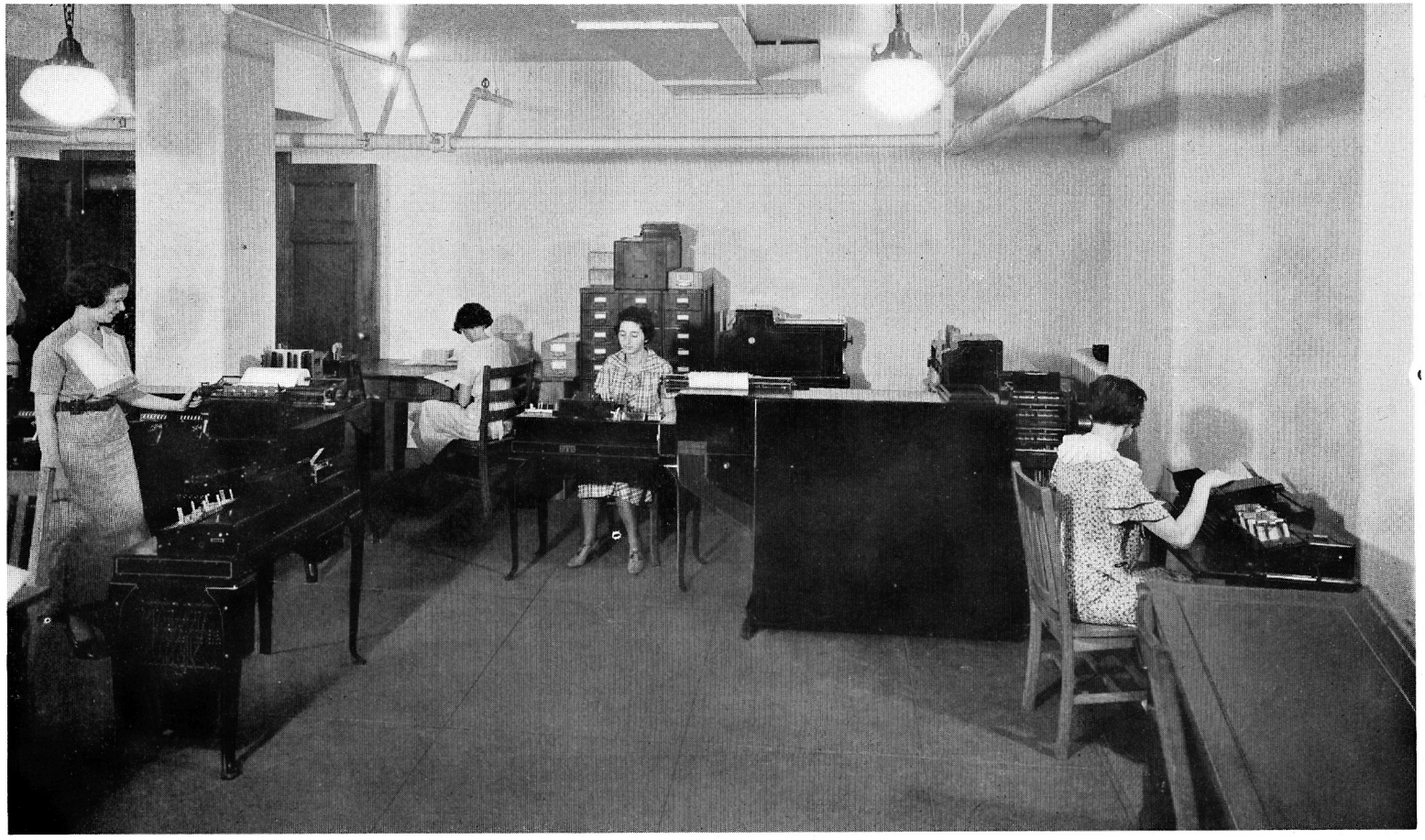


FIG. 23

A TYPICAL TABULATING MACHINE INSTALLATION (Columbia University Statistical Bureau)

PART II

Applications in the Registrar's Office

PART II

Applications in the Registrar's Office

CHAPTER I

New York University

By
H. G. ARNSDORF
Registrar

WHILE the detailed methods of student registration in colleges and universities vary almost from institution to institution, the net results are usually the same and may be very simply defined. Following the formal admission of the student and the disposal of certain other preliminary functions, the steps of the registration process are taken in definite order, and repeated each term or year, as the case may be. The major steps of the registration procedure include:

1. Approval by a faculty adviser of the student's program of courses in accordance with the requirements of the curriculum and the professional and cultural needs of the individual.
2. Computation and collection of student tuition and incidental fees by the Bursar's office. Fees vary according to the type and number of courses taken.
3. Preparation for the instructors of lists of the names of students who have completed the requirements of registration and are, therefore, eligible to attend the respective classes.

Since this is intended primarily to be a statement of the application of machine methods to the mechanical aspects of the registration procedure, Step 1 may be eliminated immediately from further consideration here. The advisement of students deals with individual differences and human values, a type of service quite beyond the sphere of mechanical operation. Likewise, we may disregard the functions included within the limitations of Step 2. Thorough familiarity with the fee schedules and ability to apply them quickly and accurately to any combination of courses is required in addition to the usual capabilities expected of an efficient receiving teller.

Although Step 3 of the registration process is almost purely clerical-mechanical, the proper performance of this and closely related functions has required most diligent consideration. At New York University extraordinary problems are created by peculiar local conditions. Here each of between 25,000 and 30,000 individual students is registered for from one to eight courses each term. The individual programs are selected from a total offering of more than 4,000 different courses or class sections given in nine of the twelve colleges and

schools under consideration. These divisions are situated in five widely-separated centers, stretching from Trinity Place to University Heights, a distance of approximately twelve miles. Advance registration on a large scale, either in person or by mail, has not been found practicable, and the majority of the students come to the various centers within a few days before classes are scheduled to begin. The peak-load of registration is usually reached the day preceding the opening of the term. Obviously then, the problem is to maintain control over the procedure throughout the University, a task accentuated by the large number of registrants, the wide spread of course offerings, the geographical separation of the various centers of activity, and the comparatively short period of time in which to accomplish the job.

Under these conditions, the essential requirements may be stated as follows:

1. As a general rule, in so far as the facilities of the University permit, students may elect work which they show promise of pursuing with profit to themselves, but no individual may enter a course for which he does not possess the academic prerequisites, or for which he has not formally registered and paid fees.

2. In order to facilitate the orderly traffic of students in buildings, some of which are taxed to capacity during certain hours of the day, each student must receive at the time of registration definite information as to the building and room to which each of his courses has been assigned, and in some cases the exact seat which he is to occupy in each room. It has not been found practicable to list the room assignments in the college bulletins.

3. Limitations of many classes as to size, because of the character of the work offered or the capacity of the class room, must be strictly observed.

4. Aside from the observance of limited registrations in certain courses, a detailed record must be maintained of the progress of registration in all sections, courses, departments, and divisions throughout the University, for administrative purposes.

5. Many students in each school elect programs of courses, some of which are offered only in other schools and often at other centers of the University. It is desirable that each student shall complete his registration at one point, no matter where he may attend classes, rather than that he be required to travel from building to building and from center to center during the time of registration.

6. Speed of operation of the registration process is necessary in order to avoid serious delays for students, especially at peak-load periods. Many of the students are adult men and women of affairs, whose time is limited.

7. Economy of clerical labor and attending expense, not only in the performance of registration functions, but of related post-registration functions, must be observed constantly.

8. Finally, a high degree of accuracy must be maintained in the disposal of the vast amount of detailed clerical work involved in the registration process.

Arrangements to meet these requirements are completed well in advance of the registration period at a time when the work of the office is least pressing. The following technique is employed:

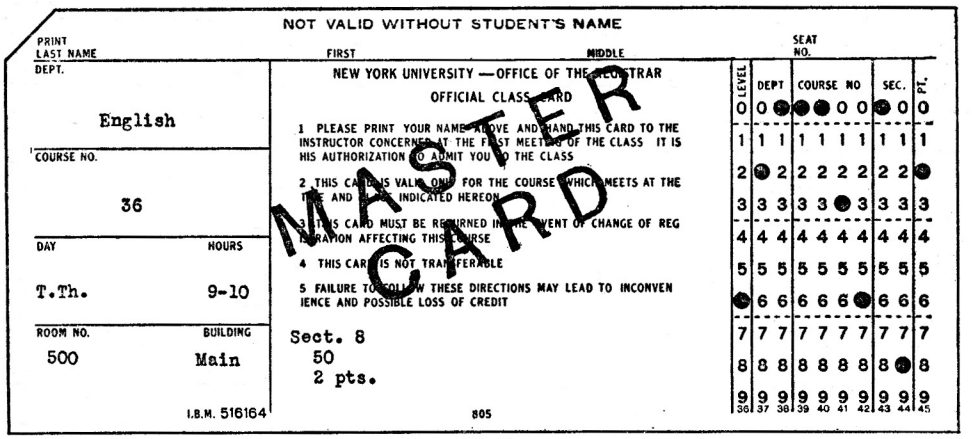


FIG. 24

1. On the basis of the detailed course offerings announced for the coming term in the current catalogs, there is prepared for each course a standard tabulating card which is designated as a "master card" (Fig. 24). On this card are recorded the name of the department in which the course is offered, the catalog number of the course, the days and hours of class sessions, and the building and room to which the course has been assigned. Indication of the various colleges and schools is given through the use of distinctively colored cards.

2. The essential information concerning the courses as required for sorting and tabulating purposes on the Hollerith machines is punched on the master card with the use of a key punch.

3. From the respective master cards there are now punched automatically by a gang punch, sufficient supplies of blank cards to meet the needs in each of the courses to be offered, counting two cards for each prospective registrant. These cards are punched at the rate of 125 a minute.

4. The punched blank cards arranged in packs, each pack including its corresponding master card, are now transferred to the duplicating department where they are printed according to the data appearing on the master cards, and numbered serially in duplicate. Printing and numbering the cards is accomplished in one operation through the use of a "type duplicator," devised especially for this purpose in the University shops. The type duplicator forms an attachment to the ordinary power-driven Multigraph.

5. The preparation of the cards now completed, the packs are stored in the respective compartments of specially constructed vertical cabinets (Fig. 31). The compartments are labeled, alphabetically, according to departments and, numerically, according to courses within the departments. The cards are now ready for distribution.

Through the employment of the class cards, prepared as just described, the eight requirements of Step 3 of the registration process are met in the following manner:

1. Class cards are issued only upon presentation by the student of his official registration card. This card must bear the written approval by his faculty

adviser of the courses elected, as well as the receipt stamp of the Bursar's office, showing that the required fees have been collected. Two class cards, each bearing the same number, are then drawn from the cabinet for each of the courses listed on the student's program. One set is attached to the registration card and retained as the office record; the other set is handed to the student. On each of his cards the student is required to print his full name, and then present it to the instructor concerned at the first session of the class (Fig. 26). The cards thus serve not only as "tickets of admission" to the respective classes thereon indicated, but they also form the basis of the instructors' official class rolls.

A change of registration is handled in the same manner as the original registration. The essential information is entered by the student on a special form (Fig. 25), which must bear the adviser's signature and the Bursar's receipt stamp, if the change involves an adjustment of fees. Together with this form, the student returns the class card for the course which he is dropping

NEW YORK UNIVERSITY
SCHOOL OF COMMERCE, ACCOUNTS AND FINANCE
CHANGE IN PROGRAM SLIP

PRINT NAME LAST NAME _____ FIRST NAME _____ MIDDLE NAME _____ DATE _____

ADDRESS _____ STATE DEGREE CERTIFICATE OR COURSE OF STUDY _____

NOTICE TO STUDENT — A CANDIDATE FOR ANY DEGREE OR CERTIFICATE MAY NOT SUBSTITUTE ANY COURSE FOR THOSE ALREADY REGISTERED FOR, WITHOUT THE WRITTEN APPROVAL OF THE FACULTY ADVISOR. A FEE OF $5.00 IS CHARGED FOR CHANGE OF PROGRAM.

The Student Must Return Class Cards For All Courses Changed or Dropped.

COURSES DROPPED						REGISTRAR'S USE ONLY		COURSES ADDED						REGISTRAR'S USE ONLY	
NAME OF COURSE	NO	DAY	HOUR	POINTS	Date of Last Attendance	FEES	TUITION	NAME OF COURSE	NO.	DAY	HOUR	POINTS		FEES	TUITION
					TOTAL								TOTAL		

REASON FOR CHANGE IN PROGRAM _____ BALANCE DUE _____

APPROVED BY FACULTY ADVISOR _____ REFUND DUE _____

APPROVED BY CLERK AT DESK No. 2 OR 4TH FLOOR COUNTER _____ BURSAR'S STAMP

FORM NO

FIG. 25

from his program and receives a new card for the course which he is adding. In due time the original registration, of course, is modified in accordance with the change-of-registration form.

2. Since the class cards for each course show the building and room in which that course is to be given, as well as the days and hours of class sessions, and the number of the seat which the student is to occupy corresponds to the number of the card, each student knows exactly where to go on the opening day of the term, thus eliminating confusion and congestion which would otherwise occur in the main traffic lanes.

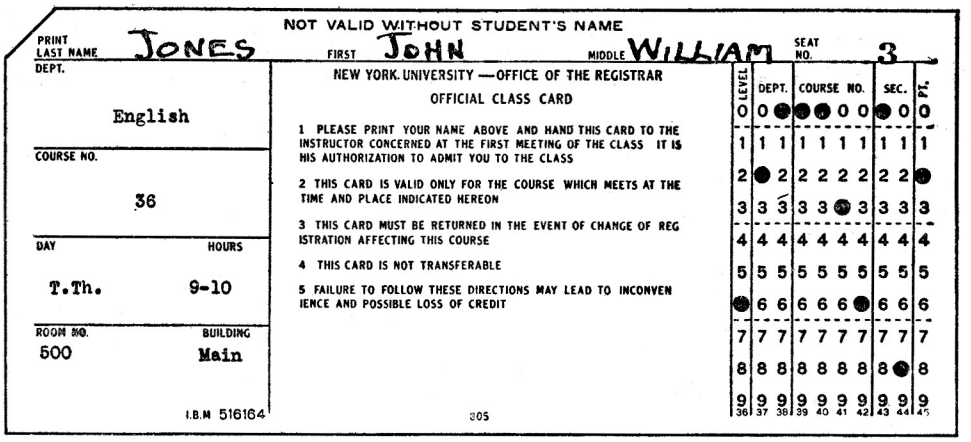


FIG 26

Completed Class Card

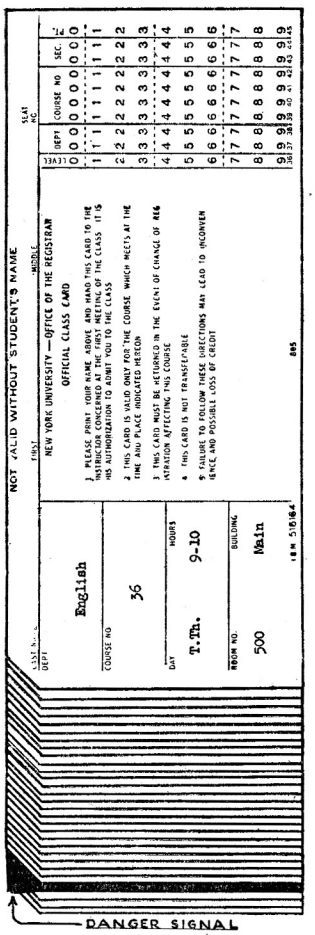


FIG. 27

3. Control over the number of students who may be accepted in courses in which the registration is limited is exercised with comparative facility. At the outset, the number of cards prepared for such courses corresponds exactly with the number of students to be admitted to them, which precludes all possibility of releasing more cards than can be accepted by the instructor. A blank "warning" card of conspicuous color is inserted three cards from the bottom of the pack in each compartment (See Fig. 27 and also lower left-hand corner on Fig. 31.) When this card is reached in the progress of registration, notification of the approaching close of registration in that course is "flashed" by telephone to the advisers' room and posted prominently on a black board for the information both of advisers and registrants. As soon as the last card for a course has been given out, the course is posted as *closed* and no further registrations for that course are approved by the advisers.

4. Information as to the progress of registration in each course and department is gathered readily at the close of each day by recording on a previously-typed list of the courses offered the registration to date in each course shown by the number appearing on the top card in each compartment. On the basis of these daily-recorded readings, it is also possible by

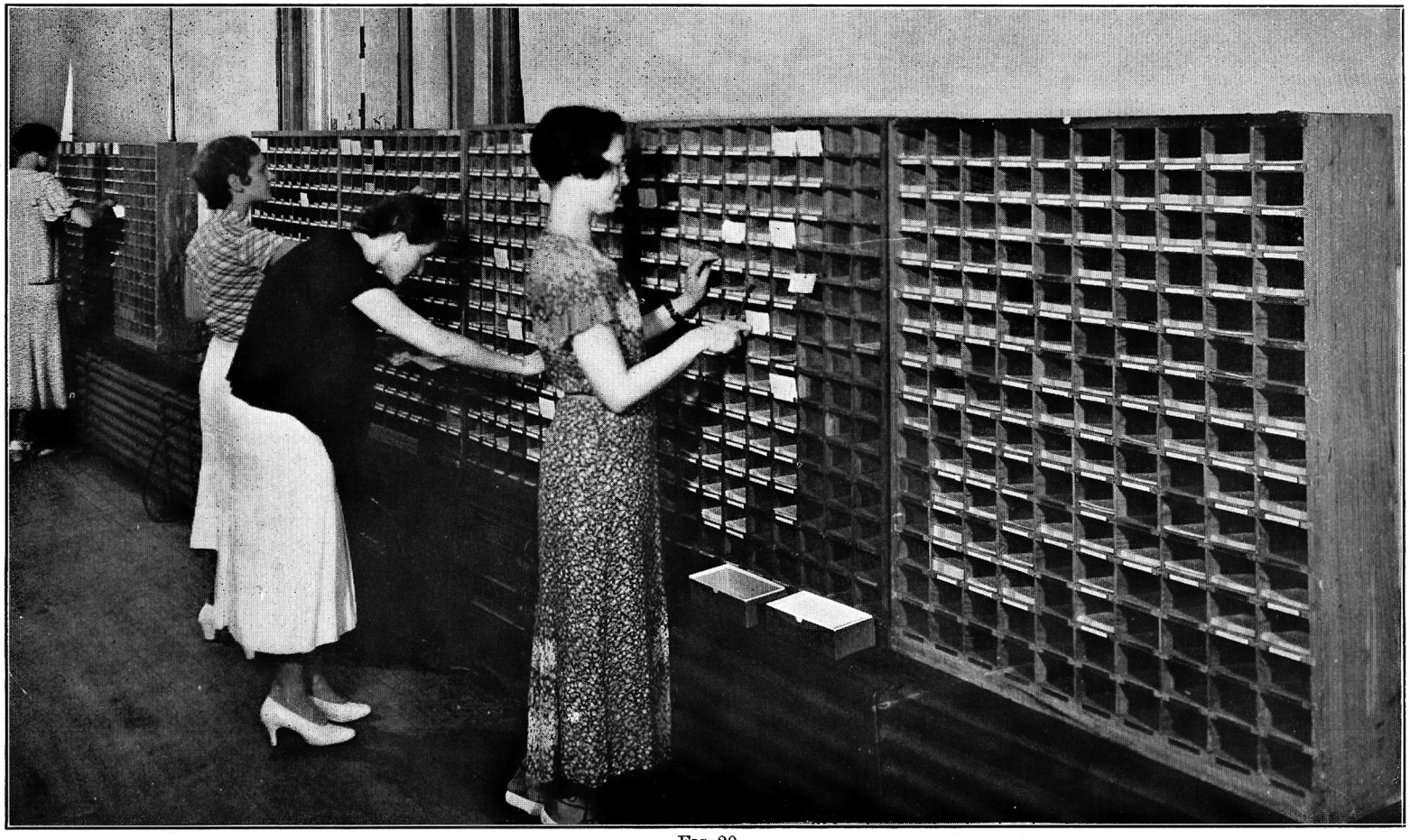


FIG 29
Scene at Registration Time, New York University

FIG. 30

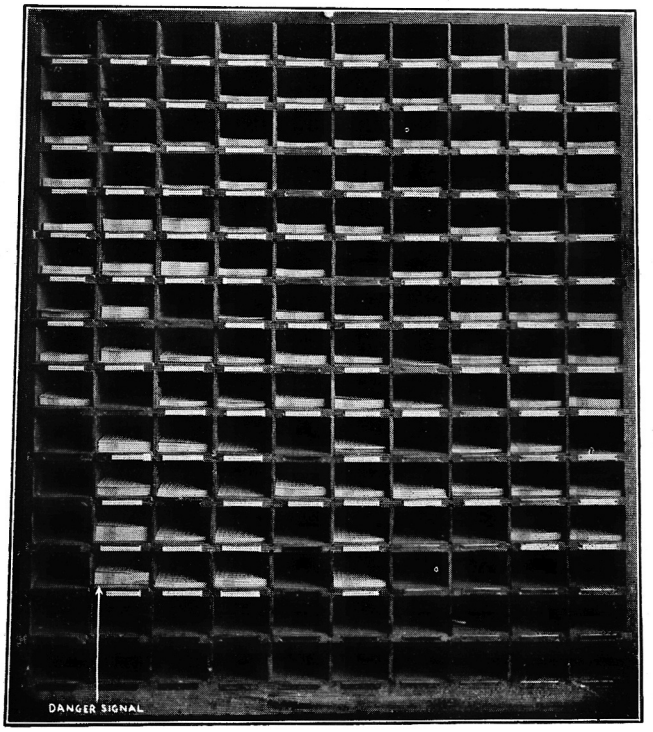


FIG 31

Above: Another scene in the registration office, New York University

At **Left: A section** of the file containing pre-punched tabulating class cards

simple computation to prepare a cumulative record of the point registration or student load by departments and colleges, during the registration period. This information is regularly cleared through the Registrar's office, which in turn

Abridged Specimen Report of Cumulative Daily Enrollment by Departments

(School of Education, Department of Sociology)

Course No.	Instructor	Day	Hour	Pts.	Enrollment by Days										
					1	2	3	4	5	6	7	8	9	Final	Total Pts.
120.3	Thrasher	Tues.	4-6	2	10	25	45	70	85	90*	90	90	90	90	180
120.5	Swanson	Tues.	6-8	2	4	14	24	55	59	64	75	78	81	81	162
120.11	Payne	Sat.	9-11	2	5	8	15	25	28	37	39	39	39	40	80
120.17	Galdston	Sat.	11-1	2	8	15	29	54	58	79	89	91	94	94	188
120.25	Belden	Tues.	6-8	2	7	9	15	19	20	45	48	48	50	51	102
120.27	Belden	Tues.	4-6	2	7	8	10	15	17	28	52	53	45	48	96
120.39	Stalcup	Wed.	6-8	2	-	2	4	6	6	12	15	18	19	20	40
120.49	Thrasher	Fri.	4-6	2	-	-	2	4	9	13	20	21	22	24	48
120.57	Brown	Mon.	1-3	2	3	5	12	18	19	29	31	33*	33	33	66
120.95	Boardman	Sat.	9-11	2	-	-	2	2	3	3	6	8	10	12	24
220.3	Payne	Fri.	6-8	3	1	3	12	20	22	51	56	45*	45	45	135
220.7	Stalcup	Sat.	9-11	3	-	2	4	6	8	16	16	17	19	20	60
220.51	Zorbaugh	Thurs.	6-8	3	2	7	15	17	18	34	44	45	48	51	153
220.69	Boardman	Thurs.	4-6	3	2	3	6	10	10	15	15	15	16*	16	48
320.3	Zorbaugh	Wed.	6-8	3	-	-	3	3	3	6	6	8	8	9	27
320.9	Thrasher	Sat.	11-1	3	1	1	1	1	2	7	7	8	9	10	30
Total				58	50	100	193	303	345	507	567	595	628	644	1,459

* Section closed.

FIG. 28

supplies to each Dean a daily report of the student-hour enrollment in each course and department, and the aggregate enrollment to date in the college or school over which he presides (Figs. 28 and 32).

5. Class cards are distributed from one point in each geographical center of the University in a room as large and accessible as can be secured. (Figs. 29 and 30.) Here the cards of each of the colleges and schools of that center are available. Students attached to any one of the schools may, therefore, secure their cards for courses in any of the other schools in the one operation and are thus spared the inconvenience of travelling from school to school or center to center and repeating this step of the registration process. Hundreds of students elect courses in more than one college or school at a center. Each of these units is administered more or less independently of the other. The interchange of students is especially marked between the two liberal arts colleges and the various professional schools.

When courses are elected which are offered at another center of the University, the clerks in charge of the various class card units at the first center *reserve* the required class cards at the second center by telephone. Cards so reserved are drawn from the cabinets and held for the students, who call for them en route to the first class session of the term, thus avoiding a special trip at the time of registration.

6. The distribution of class cards having been reduced to a mere mechanical transaction, i.e., the exchange of the student's registration card for the proper class cards, the operation is performed very rapidly. The clerks in charge of the various units become as familiar with the location of the cards in the

NEW YORK UNIVERSITY
Office of the Registrar

Daily Report of Registration for the Exclusive Use of Administrative Officers

Second Term, 1933-1934

No. 10 — Saturday, February 10, 1934

	Student Enrollment			Points of Instruction		
	Today's Comparison		At Close of Registration	Today's Comparison		At Close of Registration
	1934	1933	1933	1934	1933	1933
University College	1,248	1,214	1,215	*	*	*
School of Law	1,242	1,219	1,219	13,369	12,669	12,669
Medical College	545	543	543	*	*	*
College of Engineering	829	885	893	*	*	*
Eve'g Engineering Div.	654	725	813	5,659	6,655	7,286
Graduate School	533	736	773	3,848	5,220	5,483
School of Education	4,937	5,477	6,026	36,965	42,437	46,960
School of Commerce—						
Washington Square	4,057	4,091	4,581	44,646	48,075	52,042
Wall Street	613	610	739	3,181	3,144	3,751
Washington Sq. College	4,661	4,987	5,329	65,929	71,798	76,018
Grad. Sch. of Bus. Adm.	502	488	591	1,862	2,042	2,392
School of Retailing	183	148	178	1,982	1,906	2,058
College of Dentistry	497	495	498	*	*	*
College of Fine Arts	552	609	676	4,364	5,081	5,278
Totals	21,053	22,227	24,074	181,805	199,027	213,937
Gain since yesterday	751	1,009	—	5,740	7,237	—

* Points of instruction are not computed for divisions in which the enrollment consists entirely of full-time students.

(Signed) H. G. ARNSDORF
Registrar

FIG. 32

cabinets as with the keys of a typewriter. The work of distribution is easily regulated by supplying as many clerks as may be needed to suit the requirements at any given time. During the slack hours of registration, a student is served as soon as he appears, and even during the busiest period he is not detained longer than a few minutes.

7. The distribution of class cards is performed almost entirely by members of the permanent office staff. A few experienced student assistants are retained on an hourly basis at the busiest time. The method of distribution permits permanently-employed clerks to remain at their desks in the discharge of other duties when their services are not required at the class-card counter. At the same time, they are available at a moment's notice when the work of registration requires their attention. This feature of flexibility, therefore, obviates the

necessity of a full staff of clerks in the registration hall throughout the period, some of whom would be idle during irregular hours of the day, and also it is possible for the office to keep abreast of other pressing tasks, while registration is in progress.

Further economy is reached by sorting the duplicate class cards through the use of the electric sorting machine. The names of the students are entered on the cards as the registration period progresses, by the students themselves, and the cards are sent to the sorter immediately after the close of the period. They are promptly returned to the office arranged by courses or sections, departments, and schools or colleges. Adjustments due to approved changes of registration are then made, and the cards are ready for the tabulating machines. The printed tabulations show the final net semester-hour teaching load distributed in detail, from which various computations are readily made for administrative use. From the duplicate class cards is typed the term report form for each course, listing the names of the students for whom the instructors are required to submit reports of attendance and final grades at the close of the semester. These reports thus serve also as a check upon the class rolls as prepared by the instructors early in the term. The work of typing the reports is completed at convenient times during the term, and the forms are released to the instructors just prior to the examination period.

The very great convenience of the service of the electric sorting and tabulating machines, of course, accounts for the particular form of class card that is used and for certain obvious features of the registration procedure. The former plan of employing large groups of temporary clerks and additional typing machines to augment the permanent staff and office equipment has been abandoned entirely. Instead of long periods of high pressure effort to prepare the official class lists which were sent to the instructors late in the term, often highly inaccurate, no temporary help is now required after the close of registration, and the regular clerks are free almost immediately to return to the ordinary routine tasks of the office.

8. Freedom from pressure has greatly reduced the amount of inaccuracy in the work of student registration and in the subsequent record-keeping functions. The important clerical work is performed either before or after registration, when there is sufficient time to take the pains necessary to insure accuracy of records. Errors in the distribution of the class cards are exceedingly rare and are easily detected. The machine sorting and tabulating jobs are altogether free of error.

The application of machine methods to the more prosaic elements of the student registration and accounting problems has, therefore, served to increase operating efficiency, on the one hand, and to reduce costs on the other.

PART II

Applications in the Registrar's Office

CHAPTER II

The State University of Iowa

By
CHARLES H. MARUTH
Assistant Registrar

THE Registrar is responsible for certifying the names of all students officially enrolled, to the instructors of the various classes in the several colleges, before any student may be admitted to and continue in such classes. This can only be done when the student has completed all details of his registration and paid the required fees.

One way of accomplishing this is to have the student write a class card for each class in his study program, such cards to be checked and verified with his study program at the time fees are paid. They are then sorted by hand or machine and forwarded to the respective instructors. In a large university in which registration is confined to a period of two or three days preceding the opening of classes and in which the enrollment is in excess of 5,000 students, this means a total of approximately 40,000 cards to be sorted and distributed by the first day of classes. The time element involved in this job means the employment of a large number of clerks in order to get the work done when undertaken by hand sorting. By utilizing tabulating machines this job can be done with a minimum of hand labor and error and a maximum of speed.

The foregoing can be accomplished, as it has been in the past in this university, by using only manual key punches and the sorter.

With the facilities afforded by the alphabetic key punch and the alphabetic tabulator, it is possible to increase the service to which class cards can be put with relatively few additional machine operations, which not only enables the Registrar to fulfill his obligation of certifying to instructors the names of students officially enrolled in their classes, but also enables him to furnish a variety of services to the administration and faculty in the form of analyses which heretofore he has not been able to do because of limitations of budget and time.

This office has used the sorter for the past several years for sorting class cards and for various statistical analyses, but has been limited in furnishing various lists or classifications involving the names of students without resorting to hand check methods. The following will briefly describe what tabulating

machines are now used and how they have supplanted hand operations in connection with registration and contingent problems.

The following tabulating machines are used: (1) alphabetic punch, (2) manual key punches, (3) manual verifying punches, (4) reproducing gang punch, (5) sorter, and (6) alphabetic tabulator.

The essential feature of the machine system is the serial number assigned to each student during each session in which he registers. This number is transferred to every academic or financial transaction made during the session based on the student's registration. This permits an effective method of tying up the records of the Registrar's office with the Bursar's or business office, and permits the segregation by machine of all cards pertaining to each student's registration.

The Directory Master Card (Fig. 33)

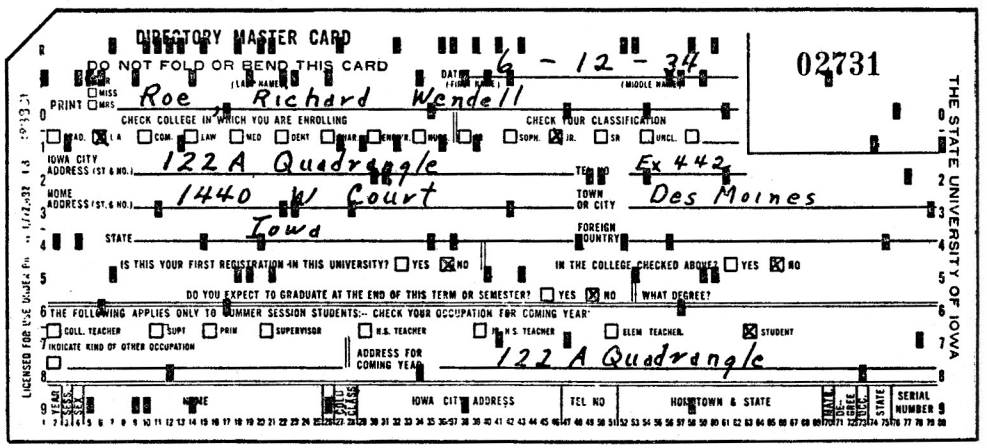
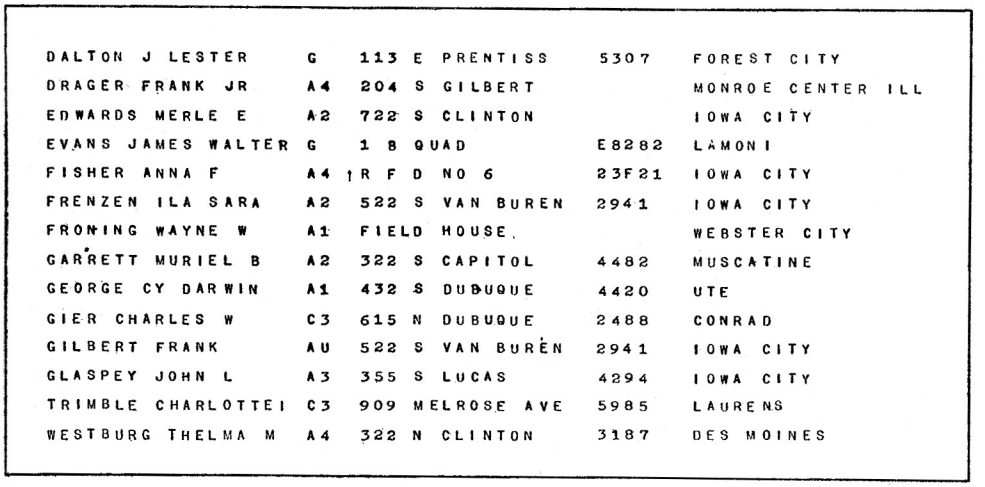


FIG. 33

The student receives with his registration materials a directory master card with a serial number pre-assigned. The master card contains the following information: (1) serial number, (2) student's surname, first name, and middle name, (3) college, classification, matriculation, and graduation index, (4) local address and telephone number, (5) home town and state, (6) year and term or semester, and (7) occupation of summer session students and location by state.

This information is written by the student and the card is filed with the Registrar when the student files his study program.

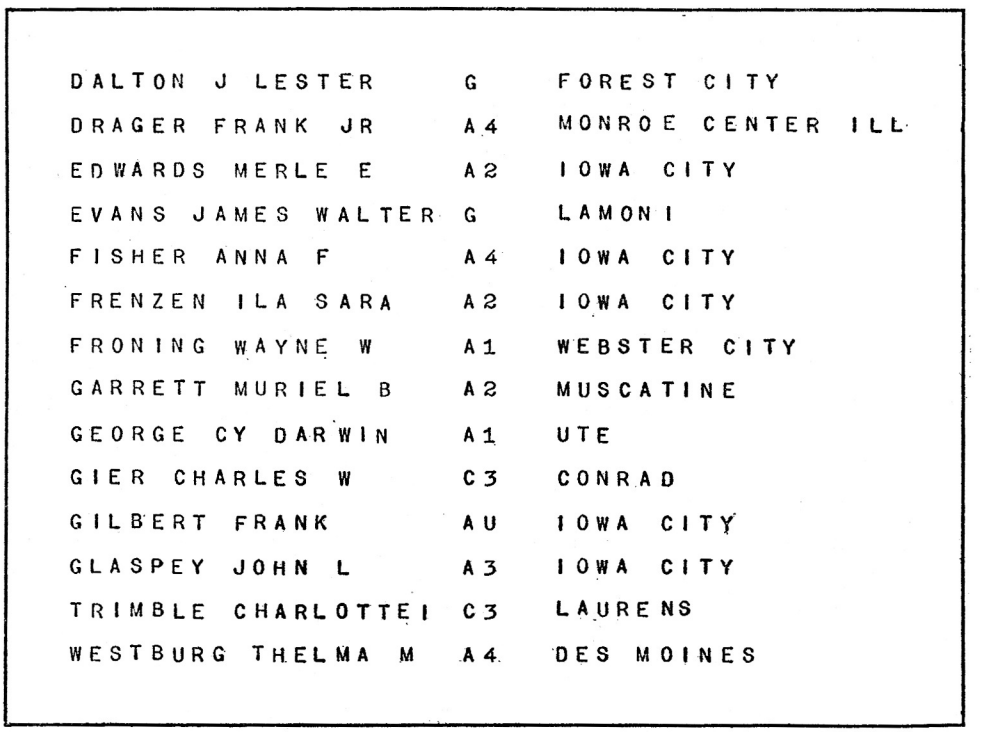
The uses of the master card are as follows: (1) for duplicating automatically certain parts of the punched information on the directory master card to (a) class cards, (b) business office analysis fee card, (c) student statistics card, and (d) other analyses forms; (2) for making lists of students according to any classification of data punched on the card including complete directory copy (Fig. 34) and catalogue roster (Fig. 35) for the printer.



DALTON J LESTER	G	113 E PRENTISS	5307	FOREST CITY
DRAGER FRANK JR	A4	204 S GILBERT		MONROE CENTER ILL
EDWARDS MERLE E	A2	722 S CLINTON		IOWA CITY
EVANS JAMES WALTER	G	1 B QUAD	E8282	LAMONI
FISHER ANNA F	A4	R F D NO 6	23F21	IOWA CITY
FRENZEN ILA SARA	A2	522 S VAN BUREN	2941	IOWA CITY
FRONING WAYNE W	A1	FIELD HOUSE		WEBSTER CITY
GARRETT MURIEL B	A2	322 S CAPITOL	4482	MUSCATINE
GEORGE CY DARWIN	A1	432 S DUBUQUE	4420	UTE
GIER CHARLES W	C3	615 N DUBUQUE	2488	CONRAD
GILBERT FRANK	AU	522 S VAN BUREN	2941	IOWA CITY
GLASPEY JOHN L	A3	355 S LUCAS	4294	IOWA CITY
TRIMBLE CHARLOTTEI	C3	909 MELROSE AVE	5985	LAURENS
WESTBURG THELMA M	A4	322 N CLINTON	3187	DES MOINES

FIG. 34

Student Directory prepared from registration cards, ready for printer



DALTON J LESTER	G	FOREST CITY
DRAGER FRANK JR	A4	MONROE CENTER ILL
EDWARDS MERLE E	A2	IOWA CITY
EVANS JAMES WALTER	G	LAMONI
FISHER ANNA F	A4	IOWA CITY
FRENZEN ILA SARA	A2	IOWA CITY
FRONING WAYNE W	A1	WEBSTER CITY
GARRETT MURIEL B	A2	MUSCATINE
GEORGE CY DARWIN	A1	UTE
GIER CHARLES W	C3	CONRAD
GILBERT FRANK	AU	IOWA CITY
GLASPEY JOHN L	A3	IOWA CITY
TRIMBLE CHARLOTTEI	C3	LAURENS
WESTBURG THELMA M	A4	DES MOINES

FIG. 35

Catalogue Roster prepared on Alphabetic Tabulator

Class Cards (Fig. 36)

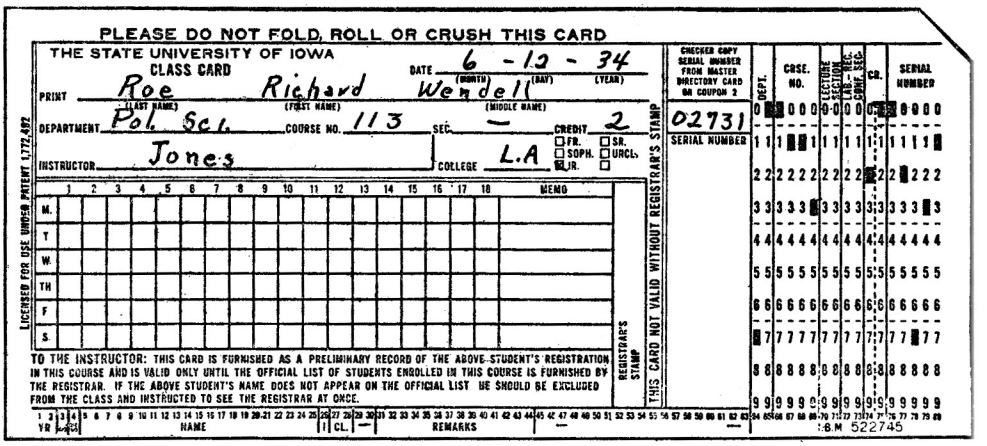


FIG 36

As soon as the student has paid the fees required by his registration, the master card and class cards are given to the punch clerks.

The following data are punched on the class cards (500 per hour per clerk on manual key punches): (1) department number, (2) course number, (3) section letter, (4) laboratory or conference section letter or number, and (5) amount of credit.

When the class card punch clerk has punched the necessary data on the class cards, the directory master card and the class cards for each student are given to the verifying punch clerk who verifies the data punched on the class cards (500 per hour per clerk on manual verifying punches).

These cards (kept intact for each student) are then given to the alphabetic punch clerk who punches the directory master card (75 per hour per clerk). After punching, the directory master card is placed on top of the punched class cards for each student and kept in this sequence.

After a sufficient number of punched directory master cards and punched class cards are available, they are collected by the clerk operating the reproducing gang punch which automatically transfers to the class cards, the punched data on the directory master card involving the student's serial number, name, college, classification, year, and session (100 per minute).

Duplicate Class Cards

After all class cards and master directory cards have been completely punched, a duplicate set of the class cards only is made by utilizing the reproducing gang punch. The original class cards bearing both written and punched information are sorted and sent to instructors on the opening day of classes as the preliminary record of students enrolled in their classes and the duplicate set is retained in the Registrar's office for making official class lists.

Department Heading Cards

Department heading cards involving the following punched data are pre-

(2nd Carbon)
THE STATE UNIVERSITY OF IOWA
Office of the Registrar

CLASS LIST

PRESIDENT'S COPY

The following students are **officially** registered for the course noted according to the records of the Registrar.

AS OF JUNE 23 1934 — 22

Date _____ — H. C. DORCAS, Registrar

INSTRUCTOR'S NAME	DEPARTMENT	CRS No	SEC.	CR.	
DAVIES	COM ECON	0176		20	1

(1st Carbon)
THE STATE UNIVERSITY OF IOWA
Office of the Registrar

CLASS LIST

REGISTRAR'S COPY

1. The following students are **officially** registered for the course noted.
2. Report on the duplicate copy furnished herewith (a) the name of any student attending this class for whom you have received a class card but whose name is not included below, and (b) any student whose name appears below but who is not attending this class.
3. Exclude from your class any student whose name does not appear below with instructions to report at the Registrar's office immediately. A regulation of the Iowa State Board of Education prohibits any instructor from receiving into his class any student not reported by the Registrar as officially registered for the class.

Date _____ — H. C. DORCAS, Registrar

INSTRUCTOR'S NAME	DEPARTMENT	CRS No.	SEC.	CR.	
DAVIES	COM ECON	0176		20	1

(Original)
THE STATE UNIVERSITY OF IOWA
Office of the Registrar

CLASS LIST

INSTRUCTOR'S COPY

1. The following students are **officially** registered for the course noted.
2. Report on the duplicate copy furnished herewith (a) the name of any student attending this class for whom you have received a class card but whose name is not included below, and (b) any student whose name appears below but who is not attending this class.
3. Exclude from your class any student whose name does not appear below with instructions to report at the Registrar's office immediately. A regulation of the Iowa State Board of Education prohibits any instructor from receiving into his class any student not reported by the Registrar as officially registered for the class.

AS OF JUNE 23 1934 — 22

Date _____ — H. C. DORCAS, Registrar

INSTRUCTOR'S NAME	DEPARTMENT	CRS No.	SEC.	CR.	
DAVIES	COM ECON	0176		20	1

	STUDENT'S NAME	COLL. and CLASS	REMARKS	CR.		
1	ANDERSON LAURETTA MAE	A		2.0		
2	BINGAMAN ROBERT F	G		2.0		
3	BISHOP HARRY	G		2.0		
4	BLOCK ETHEL MARGARET	G		2.0		
5	BOLZE CLARENCE F	G		2.0		
6	BRISCOE LAURA C	G		2.0		
7	COOK KENNETH WILLARD	G		2.0		
8	COOK KENNETH C	C		2.0		
9	CRONIN RAYMOND P	G		2.0		
10	CUSACK LAWRENCE A	G		2.0		
11	ERBE WESLEY A	G		2.0		
12	GLEYSTEEN CARL EUGENE	A	DROP 6 15	2.0		
13	HALLISY RICHARD G	G		2.0		
14	HALMSTAD CARL A	G		2.0		
15	HINES DAVID G	C		2.0		
16	JONAS RUSSELL EDWARD	G		2.0		
17	KISSICK WILL FLOREN	G		2.0		
18	KRUEGER JOHN FRED	G		2.0		
19	LICHTENHELD FRANK M	G		2.0		
20	LINDSLEY CLYDE T	G		2.0		
21	LLOYD EDWARD LESTER	G		2.0		
22	LYNAM RONALD H	G		2.0		

A43787 BURROUGHS-WARCO SYSTEMS, CHICAGO

FIG. 37

pared before registration: (1) instructor's name, (2) department in alphabet and code, (3) course number, (4) section letter, and (5) amount of credit for the course.

The Official Class List (Fig. 37)

At the end of the second or third week of classes the heading cards and class cards are sorted by department, course number and section letter, then run through the alphabet tabulator which gives complete lists of the names of students and their classification who are enrolled for each course or division thereof (80 per minute).

The official class list sent to instructors during the third week of classes will be furnished in triplicate, the original copy to be retained by the instructor; the first carbon to be returned to the office of the Registrar with (a) notations as to students attending the class whose names do not appear on the class list and (b) of students not attending the class whose names appear on the class list; and the second carbon to be forwarded to the office of the President.

Changes in Registration

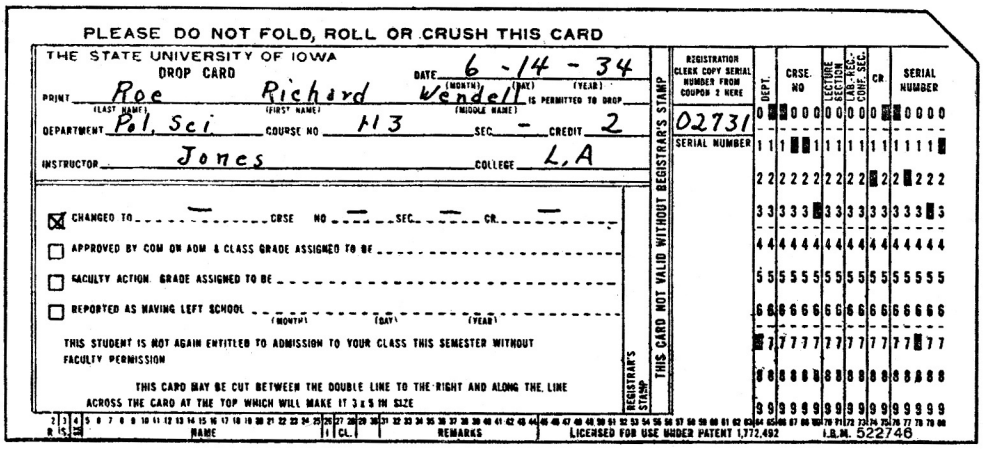


FIG. 38

Changes in registration are handled by utilizing preliminary class cards for new courses and drop cards (Fig. 38) for courses dropped, the mechanics being as above. This procedure provides supplementary lists of such changes for each instructor.

Department Load Analysis

After registration the class cards are used for analyzing the enrollment in terms of load by credit hours involved for each department and instructor.

Advance Reports on Candidates for Degrees (Fig. 39)

Before the Registrar can certify students as having completed all graduation

(2nd Carbon)

THE STATE UNIVERSITY OF IOWA
Office of the Registrar

ADVANCE REPORT ON
CANDIDATES FOR DEGREES

OFFICE COPY

1. The following candidates are registered for the courses indicated.
2. Report as much credit and as high a grade as is sure to be finally given. A higher final grade may be reported. All names listed must be reported on in the final semester or term report.
3. This form is furnished in duplicate. The carbon copy is to be retained by the department. The original (Registrar's copy) is to be returned to the office of the Registrar no later than JULY 15 1934

H. C. DORCAS, Registrar

COMMERCE
DEPARTMENT

(1st Carbon)

THE STATE UNIVERSITY OF IOWA
Office of the Registrar

ADVANCE REPORT ON
CANDIDATES FOR DEGREES

DEPARTMENT COPY

1. The following candidates are registered for the courses indicated.
2. Report as much credit and as high a grade as is sure to be finally given. A higher final grade may be reported. All names listed must be reported on in the final semester or term report.
3. This form is furnished in duplicate. The carbon copy is to be retained by the department. The original (Registrar's copy) is to be returned to the office of the Registrar no later than JULY 15 1934

H. C. DORCAS, Registrar

COMMERCE
DEPARTMENT

(Original)

THE STATE UNIVERSITY OF IOWA
Office of the Registrar

ADVANCE REPORT ON
CANDIDATES FOR DEGREES

REGISTRAR'S COPY

1. The following candidates are registered for the courses indicated.
2. Report as much credit and as high a grade as is sure to be finally given. A higher final grade may be reported. All names listed must be reported on in the final semester or term report.
3. This form is furnished in duplicate. The carbon copy is to be retained by the department. The original (Registrar's copy) is to be returned to the office of the Registrar no later than JULY 15 1934

H. C. DORCAS, Registrar

COMMERCE
DEPARTMENT

	STUDENT'S NAME	COLL. and CLASS	COURSE NUMBER	SEC.		CR.	PASS GRADE	Non-Pass Grade
1	BURTON RAYMOND JAY	G	117			2.0		
2	CARD LORENA MAY	G	117			2.0		
3	CARRELL DALE EVERETT	A	117			2.0		
4	COOK KENNETH WILLARD	G	117			2.0		
5	HALMSTAD CARL A	G	131			2.0		
6	HANSON CARL OSCAR	G	131			2.0		
7	BUSBOOM HUGH	G	139			2.0		
8	CARD LORENA MAY	G	139			2.0		
9	LUKENBACH WALTER E	G	141			2.0		
10	MANN WILLIAM H	G	141			2.0		
11	MONTZ LETA M	G	141			2.0		
12	EIKENBERRY ALICE M	G	153			2.0		
13	KISSICK WILL FLOREN	G	153			2.0		
14	MCCONKEY GLENN ALLAN	G	153			2.0		
15	HAYS ERVIN I	G	165			2.0		
16	JOHNSON MARY J	C	165			2.0		
17	KREIKENBAUM RUTH C	G	165			2.0		
18	MCGUIRE MAURICE LEE	C	165			2.0		
19	MYERS RUSSELL BROOKS	G	165			2.0		
20	KRUEGER JOHN FRED	G	193			2.0		
21	LUKENBACH WALTER E	G	193			2.0		
22	MILLER LILA MARGARET	G	193			2.0		

Date_____ Signed_____
Head of Department

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FIG. 39

requirements, it is necessary to know the status of their final semester's work.

Department heads are furnished with a complete list in duplicate of the names of all candidates for degrees and the courses for which they are registered in the respective departments about six weeks before convocation, with instructions to return to the Registrar's office the original copy after the several instructors have assigned grades.

These lists are prepared from the duplicate class cards on file in the Registrar's office through the use of the sorter and alphabet tabulator.

Final Grade Reports (Fig. 41)

Shortly before the close of any session the Registrar furnishes each instructor with final grade report forms in duplicate for his several classes. The names of the students and amount of credit for which they are officially enrolled are indicated thereon. After the instructor has indicated the grade for each student, the original copy is returned to the Registrar's office and the carbon copy kept by the instructor or department head for file.

These reports are made by the alphabet tabulator from the duplicate class cards in the same way the class lists are prepared.

Reports and Analyses

Annual Reports

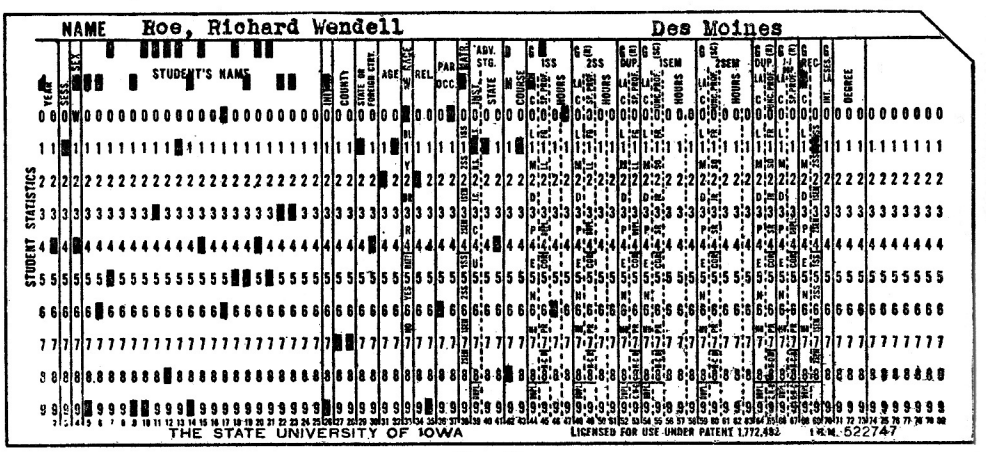

FIG. 40

For the purpose of making up the annual report to the President and State Board of Education which requires (1) a tabulation of student enrollment, (2) a geographical distribution of the student body, (3) an age distribution, (4) a religious census, and (5) a parents occupation census, tabulating machine cards called "Student Statistics" cards are used. (Fig. 40.)

A card is made for each student who registers within each fiscal year and carried forward for each session of the year. The fiscal year begins with the summer session, hence for every student who registers in the summer session a punched card is made. If that same student returns during either one of the winter sessions the same card is carried forward, new cards being made only

(2nd Carbon)
THE STATE UNIVERSITY OF IOWA
Office of the Registrar

FINAL GRADE REPORT

OFFICE COPY

1. The following students are **officially** registered for the course noted.
2. Assign one of the regular passing or non-passing grades (see reverse side for marking systems of the various colleges) to each student listed.
3. This form is furnished in duplicate. The original copy (Registrar's copy) is to be returned and on file in the Registrar's office not later than three days after the close of the term or semester. The carbon copy is to be retained by the department.
4. The Registrar's copy of this form must be signed by the instructor and countersigned by the head of the department.

DAVIES (INSTRUCTOR'S NAME) — COM ECON (DEPARTMENT) 0176 (CRS. No.) ___ (SEC.) 20 (CR.) — 22

(1st Carbon)
THE STATE UNIVERSITY OF IOWA
Office of the Registrar

FINAL GRADE REPORT

DEPARTMENT COPY

1. The following students are **officially** registered for the course noted.
2. Assign one of the regular passing or non-passing grades (see reverse side for marking systems of the various colleges) to each student listed.
3. This form is furnished in duplicate. The original copy (Registrar's copy) is to be returned and on file in the Registrar's office not later than three days after the close of the term or semester. The carbon copy is to be retained by the department.
4. The Registrar's copy of this form must be signed by the instructor and countersigned by the head of the department.

DAVIES (INSTRUCTOR'S NAME) — COM ECON (DEPARTMENT) 0176 (CRS. No.) ___ (SEC.) 20 (CR.) — 22

(Original)
THE STATE UNIVERSITY OF IOWA
Office of the Registrar

FINAL GRADE REPORT

REGISTRAR'S COPY

1. The following students are **officially registered for the course noted.**
2. Assign one of the regular passing or non-passing grades (see reverse side for marking systems of the various colleges) to each student listed.
3. This form is furnished in duplicate. The original copy (Registrar's copy) is to be returned and on file in the Registrar's office not later than three days after the close of the term or semester. The carbon copy is to be retained by the department.
4. The Registrar's copy of this form must be signed by the instructor and countersigned by the head of the department.

DAVIES (INSTRUCTOR'S NAME) — COM ECON (DEPARTMENT) 0176 (CRS. No.) ___ (SEC.) 20 (CR.) — 22

STUDENT'S NAME	COLL. and CLASS	REMARKS	CR.	PASS GRADE	NON-PASS GRADE
1 ANDERSON LAURETTA MAE	A		2.0		
2 BINGAMAN ROBERT F	G		2.0		
3 BISHOP HARRY	G		2.0		
4 BLOCK ETHEL MARGARET	G		2.0		
5 BOLZE CLARENCE F	G		2.0		
6 BRISCOE LAURA C	G		2.0		
7 COOK KENNETH WILLARD	G		2.0		
8 COOK KENNETH C	C		2.0		
9 CRONIN RAYMOND P	G		2.0		
10 CUSACK LAWRENCE A	G		2.0		
11 ERBE WESLEY A	G		2.0		
12 GLEYSTEEN CARL EUGENE	A	DROP 6 15	2.0		
13 HALLISY RICHARD G	G		2.0		
14 HALMSTAD CARL A	G		2.0		
15 HINES DAVID G	C		2.0		
16 JONAS RUSSELL EDWARD	G		2.0		
17 KISSICK WILL FLOREN	G		2.0		
18 KRUEGER JOHN FRED	G		2.0		
19 LICHTENFELD FRANK M	G		2.0		
20 LINDSLEY CLYDE T	G		2.0		
21 LLOYD EDWARD LESTER	G		2.0		
22 LYNAM RONALD H	G		2.0		

The department will please fill out and sign the following:

Course Title _____ Term or semester ending _____

Instructor's Signature _____ APPROVED: (Head of) (dep't.) _____

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FIG. 41

for the students who were not registered in the summer session. The first 26 columns of the card are devoted to the year, sex classification and mechanical alphabetization. The remaining columns are devoted to the information noted on the card. Each type of registration during each session is punched on this one card, as are the duplications, so that tabulations can be made of enrollment during any one session or any combination of sessions from these cards.

The original information which is transcribed to the punched card is recorded on the registration form. The student is required to fill out a registration form at the beginning of each session for which he registers, but the information concerning vital and personal statistics is furnished only once during each fiscal year.

The chief value of this system lies in the fact that it enables many classifications of students to be tabulated within a very short time and enables special classifications concerning the student body, including names, to be tabulated or listed quickly and accurately. It also reduces the annual report to a strictly routine job.

Student Load Analysis

For the purpose of analyzing student enrollment in terms of credit hour load, the number of semester hours undertaken each session is punched on this card.

Changes in semester hour load occasioned by students dropping part of their schedule or withdrawing from the university are punched on supplementary detail cards at the time such changes are made. This enables us to tabulate, at any time, the exact load carried by the university and permits a rapid and convenient method of compiling the information called for by the United States Bureau of Education and similar agencies involving distinctions between part and full time students.

Freshman Week

For the purpose of enabling the freshman student to more quickly orient himself in a new environment, a program of activities for freshmen has been planned covering the period beginning with the afternoon preceding the opening of the registration period and extending to the first day of classes.

Each freshman in the colleges of Liberal Arts, Engineering, and Pharmacy receives a booklet (Fig. 42), containing a separate detachable card for each event of freshman week at the time he receives his admission card or if he has not received his admission card prior to the registration period, it is issued with preliminary registration materials. The booklet consists of tabulating machine cards pre-numbered and pre-punched.

The University Examiner or the clerk in charge of distributing registration materials will detach the index card at the time the booklet is issued. The University Examiner will also detach the "University Examiner's Ticket" for all students who receive their admission card prior to the formal registration period.

The remaining tickets will be detached when the student appears for the

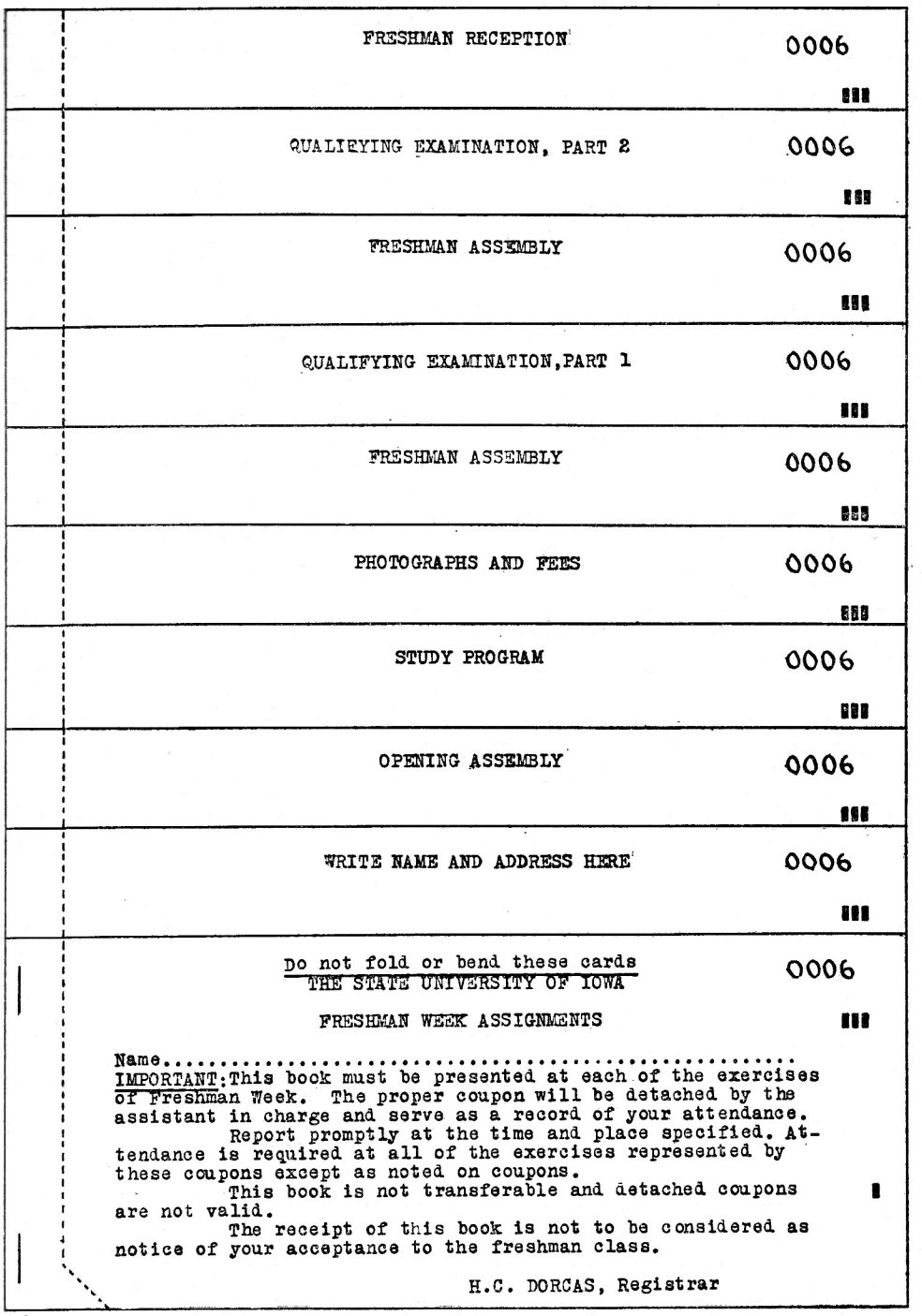


FIG. 42

This illustration shows the various cards that, padded together in booklet form, constitute the students' "admission tickets" to freshmen functions. (See text opposite page.)

respective events. By pairing such tickets with the index card (tabulating machines) it is possible to check effectively the attendance at each event,—a required check in the case of the qualifying examinations.

Special Studies

The foregoing description has been entirely confined to the routine jobs in the Registrar's office. It is apparent that with such basic records prepared for machine analysis, indices for special studies can quickly be prepared without which such studies would be impossible.

PART II

Applications in the Registrar's Office

CHAPTER III

University of Michigan

By
IRA M. SMITH
Registrar

TABULATING machine equipment is used very sucessfully by the Statistical Division of the Registrar's Office, at the University of Michigan. Owing to the fact that we have a decentralized system of recording in operation at the University, it seems inadvisable to us to use the tabulating machine card for the original record. Instead, the card is printed on the face so that the information may be typed on it, by the various Recorders, from the original records, which are kept on file in their offices. (See Figs. 43 and 44.) When these cards are typed and returned to the Registrar's Office, they give us some of the advantages enjoyed under a centralized system of recording.

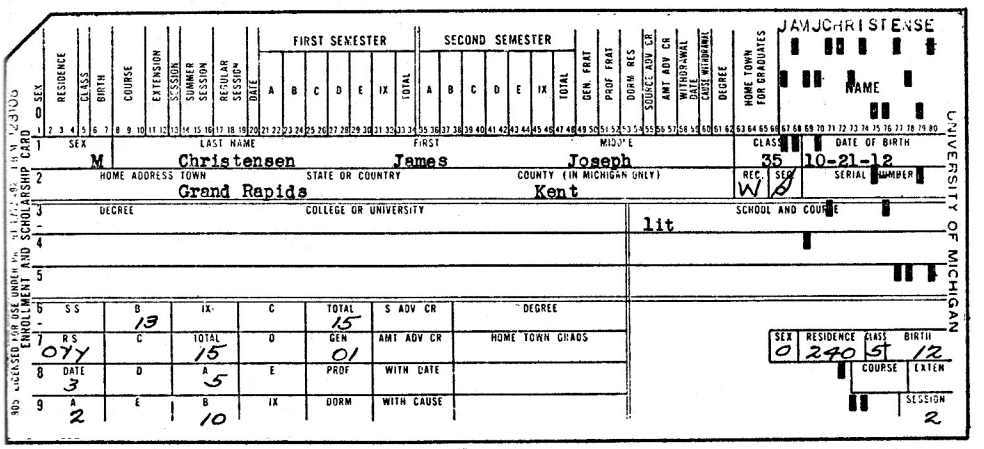
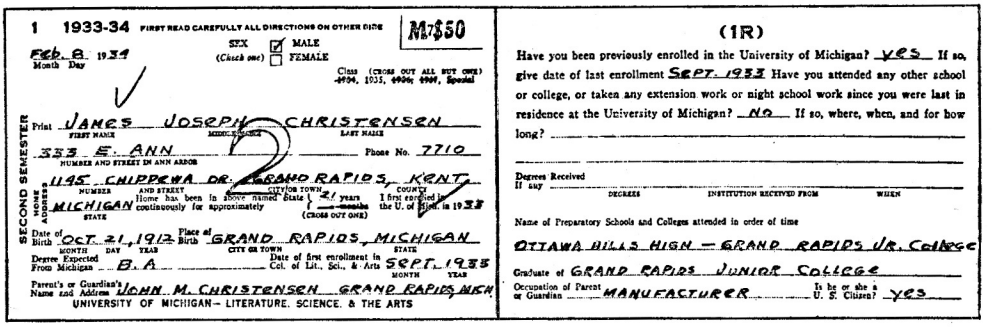


FIG. 43

Enrollment and Scholarship Card

As soon as the cards are received, they are punched for name by use of the alphabetic printing punch. This makes it possible to sort the cards from all the schools and colleges into one complete alphabetical file, on the machine. It is then necessary to take out cards for duplicate registrations. At present, this is done by hand but we are hoping that machine methods may improve still further so that even this may be done mechanically. Perhaps, however, this is asking too much from the machines, as they already save us the strain and inaccuracies of hand methods and distribute our work so that the congestion at the peak load periods may be eased off into less busy times.



1 1933-34 FIRST READ CAREFULLY ALL DIRECTIONS ON OTHER SIDE M:$50

Feb. 8 1934 (Month Day) SEX (Check one) ☑ MALE ☐ FEMALE

Class (CROSS OUT ALL BUT ONE) -1934, 1935, 1936, 1937, Special

SECOND SEMESTER

Print JAMES JOSEPH CHRISTENSEN (FIRST NAME, MIDDLE NAME, LAST NAME)

333 E. ANN (NUMBER AND STREET IN ANN ARBOR) Phone No. 7710

HOME ADDRESS 1145 CHIPPEWA DR. GRAND RAPIDS, KENT (NUMBER AND STREET, CITY OR TOWN, COUNTY) MICHIGAN (STATE) Home has been in above named State { 21 years / ___ months (CROSS OUT ONE) continuously for approximately I first enrolled in the U. of Mich. in 1933

Date of Birth OCT. 21, 1912 (MONTH DAY YEAR) Place of Birth GRAND RAPIDS, MICHIGAN (CITY OR TOWN, STATE)

Degree Expected From Michigan B.A. Col. of Lit., Sci., & Arts Date of first enrollment in this unit SEPT. 1933 (MONTH YEAR)

Parent's or Guardian's Name and Address JOHN M. CHRISTENSEN GRAND RAPIDS, MICH

UNIVERSITY OF MICHIGAN—LITERATURE, SCIENCE, & THE ARTS

(1R)

Have you been previously enrolled in the University of Michigan? YES If so, give date of last enrollment SEPT. 1933 Have you attended any other school or college, or taken any extension work or night school work since you were last in residence at the University of Michigan? NO If so, where, when, and for how long? ___

Degrees Received If any ___ (DEGREE, INSTITUTION RECEIVED FROM, WHEN)

Name of Preparatory Schools and Colleges attended in order of time

OTTAWA HILLS HIGH — GRAND RAPIDS JR. College

Graduate of GRAND RAPIDS JUNIOR COLLEGE

Occupation of Parent or Guardian MANUFACTURER Is he or she a U. S. Citizen? YES

FIG. 44

Section of original registration record

Through use of the machines, we find out readily the number of men and women enrolled, in what school or college they are taking their work, whether they attend both the regular session and summer session, their distribution by class, date of birth, etc. Through use of the sorter, we may group our students according to geographical location of home address or by course of study in the University and, when we need a record of these groupings in neat tabular form, we may use the printer. By means of a few well chosen manipulations on the plugboard and the insertion of alphabetical caption cards, we see in print that Alabama sent us 18 students, Michigan 8,656, Sweden 1, etc., of our total 13,257 enrolled, or that 256 students in the Graduate School regular session specialized in Education, only 1 chose Classical Archaeology, etc. These results need no translation, even for those inexperienced in statistical compilations.

Perhaps our most sightly machine production is the scholarship chart. We punch our cards to show the hours of "A" grade, "B" etc., received by the student during each semester of attendance. We also indicate his affiliation with dormitory, fraternity or league house. When these cards are punched and sorted, they are put in the tabulator and again, as the result of a few intelligent connections on our plugboard, the machine selects and rejects so that affiliates of one semester only are included for that semester, rejected for the other, and members for both semesters are recorded for both. These are all neatly tabulated on individual sheets for each group (See Fig. 45) and, through insertion of caption cards, are clearly labeled, ready for inspection by the groups. It is thus possible to place before each organization complete scholarship records, which enable it to detect at a glance its weak and strong members scholastically. And the machine does most of the work.

We are also asked each year to supply for the newspapers a list of graduates, by degree and home address. This information is furnished as a rush order, since it must be given out after the "lame ducks" have fallen by the wayside, between the time of the examinations and Commencement when not many hours are left for the work to be done. Through use of the tabulating machine card, information concerning degree expected and home address may be punched on the card early in the semester when there is plenty of time. At the last minute, cards for non-graduates may be hastily withdrawn and, at the

UNIVERSITY OF MICHIGAN

1933 - 1934 SCHOLARSHIP RATING

——— FRATERNITY

Name	Frat. No.	First Semester						Second Semester					
		A	B	C	D	E	Total	A	B	C	D	E	Total
H B ABBOTT	01	3	3	4	4		14	7	4	4			15
J P BACON	01	7	4	4			15	3	3	4	4		14
S E COOPER	01			15			15		3	12			15
G A DANKERS	01	7	8				15	4	3	3	4	1	15
C B EMERT	01		8	7			15	3	4	8			15
R R FISHER	01	3	3	4	4		14		3	12			15
P J GORMAN	01	7	4	4			15	7	8				15
E P HALL	01			12			12		8	5			13
J G JENKINS	01	4	3	3	4	1	15	7	4	4			15
J G KITCHEN	01		3	12			15			12			12
R K MOSHER	01		10	3	2		15			10	3		13
P J NUTTER	01	7	4				11		8	3			11
J D PARKER	01		6	9			15		7	6			13
D A RICHARDS	01				15		15			15			15
W E SCHILLER	01	13					13	12	3				15
J R SMITH	01		15				15	7	8				15
R O THOMAS	01		8	7			15	3	4	8			15
S ULLMAN	01			12		3	15		8	5			13
S V WELLS	01	4	3	3	4		14	7	4	3			14
D H WRIGHT	01		3	10			13			13			13
TOTAL HOURS		55	85	109	33	4	286	60	82	127	11	1	281

NOTE:- To figure the percentage rating, multiply the hours of A by 100; B by 85; C by 70; D by 50; and E by 20. Divide by the total number of hours.

FIG. 45

final reckoning time, the machine does the rest of the work, with the advantage that it doesn't know Commencement is so near at hand and doesn't grow excited and consequently inaccurate over the fact that 2,597 cards must pass by it several times before the world may know, through the Press, that another graduation has taken place.

PART II

Applications in the Registrar's Office

CHAPTER IV

The University of Texas

By

MAX FICHTENBAUM

Assistant Registrar

WE are called upon, as are other registrars, to furnish a considerable variety of information concerning our students, such as number registered, classification by colleges, by rank, etc., geographical distribution, religious affiliation, occupation of parents, etc. In addition to this type of information we furnish data as to quantity of work students take, the quality of their work, grade averages according to different groupings, data concerning departmental teaching loads, analyses of entrance units presented by freshmen, correlation of freshman records, etc. Our enrollment in the long session is above 6,000.

For years the statistical tabulations involved in these and similar reports were compiled by hand checking methods. During the session of 1929-1930 we investigated the possibilities of using machinery to do our statistical work, and in the spring of 1930 we installed Hollerith equipment for this purpose.

We now use the following equipment: an automatic electric duplicating punch, a horizontal counting sorter, and a tabulator.

One of our first problems in connection with using these statistical machines, in order to obtain maximum results, was to design a card form on which all of the necessary basic data could be recorded in such manner that correlations could be had between any item of the personal information and the student's scholastic record.

We use a 45-column Hollerith card (Fig. 46) and in it we punch all of the personal information which we wish to tabulate concerning the student, and in the same card we punch the scholastic record showing courses registered for, grades received, hourage earned, etc. Through the use of an electric duplicating punch a separate card is punched for each different grade in each course taken by each student. By having courses, grades, and hours on the same card with the personal data for the student, we are able to secure an endless number of correlations and averages for different groupings of students or courses.

In preparing our statistical cards for the basic tables, a master file of Hollerith cards is first made up, one card for each student who has registered for the session. The student's name is typed at the top of the card. Since our coding involves several lengthy codes and the use of a number of different office records, we found it helpful to use an intermediate card (Fig. 47) on

which to enter our information before it is punched in the Hollerith card. The student's name is typed on the intermediate card and then the various personal data are entered in code from the original sources. Exception: the first ten columns are punched directly on the statistical card, as explained below. This procedure simplifies and speeds up the punching of the Hollerith card since the operator has no coding to do as he punches.

Subsidiary master cards are prepared for special types of data. For instance, a separate set of cards is made for freshman students and detailed studies are made from these cards concerning entrance units presented, correlation of aptitude tests, high school and college performance, etc.

We use a colored Hollerith card for our master file and manila Hollerith cards for the general grade cards. The use of these will be explained more fully later. The card forms are exactly the same.

The column heads on our Hollerith card are in the main self-explanatory. An explanation of a few may be necessary. The item "Auditor's number" (columns 1-4) is used for identification of the manila grade cards, since these do not have the students' names typed on them. (Each student's "permit" or course card is given a serial number by the finance office when the student pays his fees.) The "name" item (columns 5-7) is used merely to facilitate alphabeting the master file. "General average elimination" (column 32) and "Specific semester used" (column 33) are used in connection with calculating a general all-University average for fraternity eligibility purposes.

Columns 1 through 10 are punched immediately after registration in the fall so that preliminary reports of registration by sex, colleges, modes of admission, etc., may be had. The various November 1st reports asked of registrars are also tabulated from this first punching.

Columns 11 through 36 are coded on the intermediate card and punched in the Hollerith master card during the session and various tabulations such as Modes of Admission, Geographical Distribution, Nativity, Religious Preference, Parent's Occupation, etc., are compiled. These tabulations are made up in the spring in order that second semester registrations may be included.

Changes in columns 34, "Withdrew," and 35, "Number Semesters Completed", are made at the end of the session to adjust for withdrawals after the master cards are punched. These columns, however, do not affect any previous tabulations, but are used in connection with student grade averages which are compiled after the close of the session.

After the session has closed and after grades are recorded in the office, manila Hollerith cards are punched to record courses taken, grades received, etc. This completes the "Scholastic Record" item (columns 39-45). We use a Hollerith electric duplicating punch for this purpose and duplicate on the manila grade card all the information previously punched on the master card, that is, columns 1-38. A separate manila card is punched for each different grade in each course for each student. This enables us to correlate any item of the personal information with any or all of the scholastic record. For each student, therefore, we punch one master card and one or more manila grade cards, the number of the latter depending on the number of courses taken and grades made.

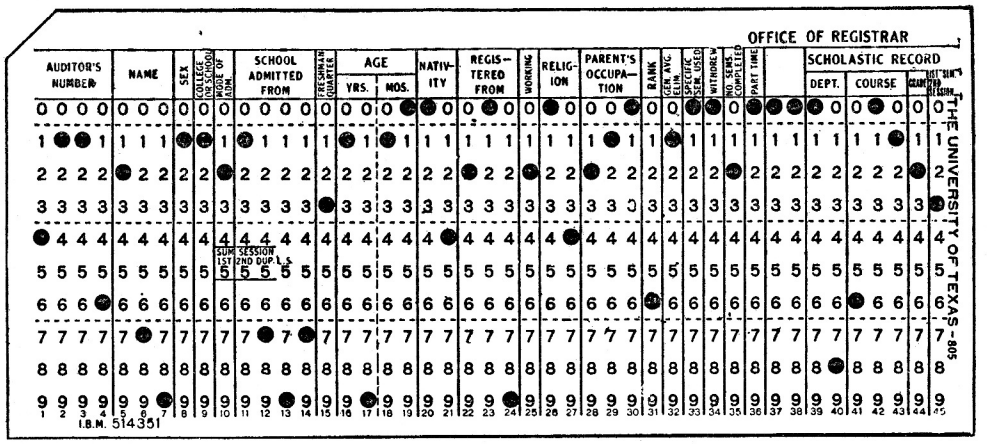


FIG. 46

Doe, John

Intermediate Statistical Card

1–4: Auditor's Number	4116	16–19: Age	19:10	32: Gen. Avg. Elim.	1
5–7: Name	279	20–21: Nativity	04	33: No. Countable Semesters	0
8: Sex	1	22–24: Registered from	209	34: Withdrew	0
9: College or School	1	25: Working	2	35: Number Sems. Completed	2
10: Mode of Adm.	2	26–27: Religion	04	36: Part Time	0
11–14: School Adm. from	1797	28–30: Parent's Occupation	210	37:	
15: Freshman Quarter	3	31: Rank	6	38:	

F-44

FIG. 47

The course numbering plan in use at The University of Texas is especially well adapted for recording on the statistical card. I quote excerpts from our bulletins explaining our course numbering:

> "The unit of measure for credit purposes is the semester hour. . . . Courses are designated by numbers . . . which indicate both rank and credit value in semester hours. . . . A number between 200 and 299 indicates a value of two semester hours, one between 300 and 399 a value of three semester hours, etc. The two digits on the right indicate the rank of the course; if between 0 and 9 the course is of freshman rank; if between 10 and 19, of sophomore rank; if between 20 and 59, of junior rank; if between 60 and 79, of senior rank; if between 80 and 99, of graduate rank."

Each teaching department is given a code number (columns 39-40). The course number is punched in columns 41-43 on the manila cards. The value of the course in semester hours is shown in column 41, and by adding the value of the punches in this column for a specific group of cards we obtain the total hourage registered for, passed, or failed, according to the sort previously made on the grade column (column 44). The rank of the course is shown in column 42, and by sorting the grade cards on this column information classified according to the rank of courses is obtainable.

Some of our courses are completed in one semester, while others continue through the session. In punching the grade cards we punch a separate card for each different grade earned in each course by each student. As an illustration, if a student has a particular course which extends through the session, and he received a grade of B on the first semester and a grade of C on the second semester of the course, a separate card is punched for each half of the course. The hourage value for each half is shown proportionately on each card in column 41. Assume that the course is an eight-hour course (four hours each semester) numbered 821 extending through the session and that the student received grades of B and C as mentioned above. Two grade cards would be punched, each carrying the course number 421 in columns 41-43, but the first card would show a grade of B in column 44 and first semester in column 45, while the second card would be punched to show grade C in column 44 and second semester in column 45.

As a second illustration, assume that the student received a grade of B on each semester of the same course mentioned above. Only one card would be punched. The course number 821 would be punched, the 8 in column 41 indicating that the course value was eight hours. The grade B would be punched in column 44, and column 45 would be punched to show the grade was for the entire session.

In each of these cases column 41 would show a total hourage value of eight. This plan of punching permits all grades to be indicated with the hourage value governed by each grade rank. In calculating group averages it is very important that grades and hourage governed by those grades be properly and fully shown.

Column 45 is punched to show the semester in which the specific course recorded was taken. The information in this column permits correlation of other data with grades and hours by semesters, and makes possible the calculation of group averages by semesters if needed.

The tabulating card (Fig. 46) is typical of the cards we punch and records the following information:

Columns	1–4	Auditor's number: 4116
"	5–7	Name: John Doe
"	8	Sex: Male
"	9	College or School: Arts and Sciences
"	10	Mode of Admission: From Texas secondary school
"	11–14	School admitted from: Terrill School
"	15	Freshman quarter: 3rd

"	16–19	Age: 19 years, 10 months
"	20–21	Nativity: California
"	22–24	Registered from: Shackelford County (Texas)
"	25	Working: Has earned or is earning all expenses
"	26–27	Religion: Is a member of the Christian Church
"	28–30	Parent's occupation: Service car operator
"	31	Rank: First-year freshman
"	32	Gen. avg. elim.: Yes
"	33	Specific sem. used: Neither semester
"	34	Withdrew: No
"	35	No. sems. completed: 2
"	36	Part time: No
"	39–40	Dept.: English
"	41–43	Course: 601
"	44	Grade: B
"	45	Semester: Grade is for a full session

Explanation of Codes Used, etc.

Name—columns 5-7. A three-column code is used for this item, the numbers running from 001 through 999.

Sex—column 8. Only two numbers are needed here: 1, male; 2, female.

College or school—column 9. We have seven colleges and schools at the Main University, and our code is:

1—College of Arts and Sciences
2—School of Business Administration
3—School of Education
4—College of Engineering
5—Graduate School
6—Law School
7—College of Pharmacy

Mode of Admission—column 10. A student may gain admission to the University in one of eleven ways. We therefore need only a one-column code. It is as follows:

1—Readmission to the same college or school
2—From Texas secondary schools
3—From out-of-state secondary schools
4—From Texas senior colleges
5—From out-of-state senior colleges
6—From Texas junior colleges
7—From out-of-state junior colleges
8—By individual approval
9—By interdepartmental transfer
11—By entrance examination
12—By combination of entrance examinations, high school certificate, etc.

School admitted from—columns 11-14. Each school in Texas, both secondary and of college grade, is assigned a code number. Secondary schools are listed in a bulletin on accredited schools issued by our State Department of Education, and this forms the basis of our secondary school code.

There are between 75 and 100 colleges in the State, and we receive students from nearly all of them. We use a code that permits us to separate the cards with a minimum number of sorts by type of school or by specific institution. The plan of the code is thus:

1000–1999—Texas secondary schools
3000–3499—Texas senior colleges, subdivided as follows:

3100 series—State Teachers colleges
3200 series—Other State supported schools
3300 series—Denominational schools
3400 series—Other schools

5000–5299—Texas junior colleges, subdivided as follows:

5100 series—Municipal and State supported colleges
5200 series—Denominational and private colleges

We do not attempt to code out-of-state schools by specific institution, but only by type, thus:

2000—Out-of-state secondary schools
4000—Out-of-state senior colleges
6000—Out-of-state junior colleges

Freshman quarter—column 15. This refers to the quarter of the graduating class in which the student ranked in the secondary school, and is punched only in the case of new freshmen coming to us directly from secondary schools. The code is:

1—First quarter
2—Second quarter
3—Third quarter
4—Fourth quarter
5—Unknown or not given
6—New individual approval students—not secondary school graduates

This same column is used to record data concerning transfers from junior colleges. In working out the scholastic performance records in the University of transfers from junior colleges, we indicate on the statistical cards whether or not the student is a graduate of the junior college, and in compiling the performance records prepare comparative statements of the performance of the junior college graduates and non-graduates.

The coding is 7 for a graduate and 8 for a non-graduate.

We use only one punch in a column, but the above do not conflict since the students entering from high schools and those entering from junior colleges are in different categories.

Age—columns 16-19. We punch the student's age in years and months, and calculate each student's age up to October 15 of the session involved.

We assume a common birthday as the fifteenth day of each month, thus avoiding fractions of a month. We found by actual test that the birthdays were approximately evenly distributed between the first half and the last half of each month.

Nativity—columns 20-21. We tabulate nativity by states, territories and possessions, and foreign countries. A two-column code, numbered from 01 to 99 takes care of our needs, each state, etc., being assigned a code number.

Registered from—columns 22-24. This provides for our geographical distribution report of students. We use a three-column code and distribute according to counties in Texas, states, territories and possessions, and foreign countries. Each county, state, etc., is assigned a code number.

Working—column 25. This refers to the student who has earned or is earning a portion of his expenses. This information is taken from a blank filled out by the student at registration.

Religion—columns 26-27. The student is asked at registration to indicate his church membership, or if not a member, his preference. We list the various denominations alphabetically, and use a two-column code, assigning the numbers 01 to 49 to indicate membership, and 51 to 99 preference. Thus a student who is a member of the Methodist Church is punched 16, and one who is not a member but prefers the Methodist faith is punched 66.

Parent's occupation—columns 28-30. We use a three-column code for occupations, numbering from 001 to 999. We classify the various occupations under ten main divisions with as many subdivisions under each as may be needed. The general plan of this code is:

0 series—Agriculture, animal husbandry, fishing, and forestry
100 series—Extraction of minerals
200 series—Manufacturing and mechanical industries
300 series—Transportation
400 series—Trade
500 series—Public service
600 series—Domestic and personal service
700 series—Professional
800 series—Clerical
900 series—Miscellaneous

We prepare for the operator's use a complete alphabetical list of all the occupations involved with appropriate code numbers.

Rank—column 31. There are ten possible ranks or classifications at the University, exclusive of graduate students, and therefore a one-column code is sufficient, as follows:

0—Graduate student
1—Freshman other than first year
2—Sophomore

3—Junior
4—Senior
5—Fifth year (holder of degree but doing undergraduate work)
6—First-year freshman
7—Junior law
8—Middle law
9—Senior law
11—Individual approval student (other than first year) whose entrance conditions are not satisfied.
12—Special

Withdrew—column 34. This is to indicate the students who withdrew each semester. The code used shows the time of withdrawal.

Number of Semesters—column 35. This is to record the number of semesters the student completed during the session, and is used in calculating various group averages. The punching is 0, 1, or 2, as the case may be.

Part time—column 36. This is to indicate the student who carries less than the normal load. Those who carry less than twelve semester hours are considered part time. The count for this item is made as of the end of each semester since a student may be part time in one semester and carry a normal load in the other. This information is necessary in arriving at accurate group averages. We use a code which indicates the different possible combinations for part-time and full-time students.

Department—columns 39-40. Each teaching department is assigned a code number. These are blocked off according to colleges and schools in order that the cards may be arranged by departments within colleges and schools with a minimum number of sorts. Thus the numbers 01 to 29 are assigned to departments in the College of Arts and Sciences; 30 to 39 to the School of Business Administration; 40 to 49 to the School of Education; etc.

Course—columns 41-43. The course number is punched according to the hour-age value as explained on page 50.

Grade—column 44. Our grades are coded in one column as follows:

1—A
2—B
3—C
4—D (lowest passing grade)
5—E (condition)
6—F, G (failure)
7—Examination or work officially postponed
8—Incomplete or grade missing
9—Dropped course officially or withdrew from school
11—Dropped course officially with a failing grade

1st sem., 2nd sem., session—column 45. This column is used to indicate the semester in which the course punched on that specific grade card was taken. The code is 1 for first semester, 2 for second semester, and 3 if the course is punched for the entire session.

Accuracy Checks

Certain of our codes when punched can be checked on the sorter against each other for accuracy of coding and punching. As an illustration, first-year freshmen may be classified by rank (column 31) in only two groups—6 or 12. So if we sort on column 10 (Mode of Admission) and take out the cards for all students who were admitted as first-year freshmen and then sort these cards on column 31 (Rank), we would find they were all sixes or twelves. Any other punch in this column would show an error. Similarly, law students may have only one of four possible rank classifications. They must be junior, middle, senior, or special laws. By sorting the appropriate columns any error of this type in coding or punching will be disclosed. It is not possible, of course, to verify all of the different columns in this manner. To insure accuracy of the more important items on the master cards, after columns 1 through 10 are punched, the punched card is checked back against the original sources before any tabulations are made.

Types of Statistical Work Compiled

We compile from our statistical cards certain tabulations for our annual report, and in addition work up a number of special reports giving averages, etc., for different groupings of students. Special studies are also made as occasions arise.

Some of our reports and tabulations are:

Monthly and session registration by sex, college or school, and rank

Modes of admission by sex and college or school

Nativity

Geographical distribution

Church affiliation and preference

Occupation of parents

Working students

Student ages by rank and college or school

Summary of semester hours registered for, passed, and failed classified by subjects, colleges and schools, rank of courses, and grade earned

Analysis of performance of first-year freshmen grouped according to rank in high-school graduating class—analysis by sex, college in which registered, grades, and hours earned

Averages of freshmen coming from accredited schools in Texas arranged by schools from which admitted

Comparison of November 1 registration with preceding year by sex, college or school, and mode of admission

Analysis of courses taken by graduate, senior, and junior students according to rank of students, rank of courses taken, and grades earned

Monthly report of departmental loads by rank of courses

Analysis of subjects presented by freshmen for admission

Correlation of high school performance, aptitude tests, and college performance.

A few of these reports are illustrated on the following pages (See Figs. 48 to 53).

Geographical Distribution of Students in the Main University and in the School of Medicine for the Session of 1932-1933, and in the Main University for the Summer of 1933

	Main University	School of Medicine	Long Session Total	Summer Session 1933		Main University	School of Medicine	Long Session Total	Summer Session 1933
I. Texas Counties	6195	339	6534	2723	Crosby	5	0	5	1
					Culberson	1	0	1	1
					Dallam	3	0	3	1
Anderson	31	1	32	11	Dallas	407	8	415	73
Andrews	1	0	1	0	Dawson	3	0	3	4
Angelina	24	0	24	9	Deaf Smith	6	1	7	1
Aransas	1	0	1	0	Delta	0	2	2	2
Archer	5	0	5	4	Denton	25	2	27	15
Armstrong	1	0	1	1	DeWitt	35	2	37	13
Atascosa	12	0	12	7	Dickens	2	0	2	3

FIG. 48

Church Affiliation and Preference of Students in the Main University for the Session of 1932-1933

	Members			Preference			Total		
	Men	Women	Both	Men	Women	Both	Men	Women	Both
Adventist	1	0	1	1	0	1	2	0	2
Baptist	808	353	1161	145	27	172	953	380	1333
Catholic	265	136	401	21	3	24	286	139	425
Christian	254	165	419	49	14	63	303	179	482
Christian Science	27	23	50	25	24	49	52	47	99
Church of Christ	88	48	136	11	0	11	99	48	147
Congregational	19	19	38	9	0	9	28	19	47
Disciple of Christ	3	0	3	0	0	0	3	0	3
Episcopal	249	211	460	41	32	73	290	243	533
Evangelical	6	4	10	4	1	5	10	5	15
Friends	2	0	2	0	1	1	2	1	3
Greek Orthodox	6	1	7	2	1	3	8	2	10
Jewish	158	84	242	51	19	70	209	103	312
Latter Day Saints	1	2	3	0	0	0	1	2	3
Lutheran	104	54	158	23	5	28	127	59	186
Methodist	1143	592	1735	191	54	245	1334	646	1980
Moravian Brethren	2	2	4	1	0	1	3	2	5
Nazarene	0	1	1	0	0	0	0	1	1
Presbyterian	503	285	788	70	38	108	573	323	896
Quaker	1	0	1	0	0	0	1	0	1
Spiritualist	0	1	1	0	0	0	0	1	1
Unitarian	4	0	4	8	4	12	12	4	16
Universalist	1	1	2	1	0	1	2	1	3
Total	3645	1982	5627	653	223	876	4298	2205	6503
Not Given	56	25	81	--	--	--	56	25	81
No Preference	--	--	--	125	30	155	125	30	155
Grand Total	3701	2007	5708	778	253	1031	4479	2260	6739

FIG. 49

Summary of registration, passing, failing, grades earned, etc. for Long Session 1932-1933

	Total sem. hrs. registered for	% Pass	% Fail	Of total passing grades, per cent passed with grade of			
				A	B	C	D
ARTS AND SCIENCES	124965	78.1	13.1	16.9	28.3	33.6	21.2
Anthropology	1737	87.9	6.2	26.9	32.0	27.5	13.6
Applied Math	4311	54.3	30.6	26.3	21.4	25.3	27.0
Bacteriology	1161	84.8	6.2	14.6	30.5	39.3	15.6
Botany	1936	86.7	6.0	22.5	34.9	28.8	13.8
Chemistry	9557	72.1	19.1	22.4	27.7	28.8	21.1
Czech	383	91.4	3.9	36.9	42.0	19.4	1.7
Economics	8156	80.1	11.6	14.2	26.5	35.4	23.9
English	21857	78.4	13.2	12.4	27.8	36.6	23.2
French	5810	77.1	15.1	22.2	25.6	30.1	22.1
TOTAL	174410	79.0	12.3	16.0	28.8	34.2	21.0

The sum of the figures in "Percent Passed" and "Percent Failed" columns does not always equal 100% because the figure for dropped courses, withdrawals, incompletes, etc., is not shown in this report.

FIG. 50

Occupation of Parents of Students in the Main University for the Session of 1932-1933

Agriculture, Animal Husbandry, Fishing and Forestry:

Cattleman or Stockman	54	
Dairyman	17	
Farmer	618	
Florist	8	
Gardener	4	
Horticulturist	13	
Lumberman	60	
Lumber Dealer	22	
Nurseryman	9	
Poultryman	3	
Rancher	131	
Truck Farmer	1	
		940

Extraction of Minerals:

Driller	11	
Geologist	7	
Miner	3	
Mine Owner	1	
Oil Field Worker	25	
		47

Manufacturing and Mechanical Industries:

Baker	10	
Blacksmith	9	
Boilermaker	2	
Bookbinder	2	
Bottler	4	
Bricklayer	1	
Cabinet Maker	6	
Carpenter	48	
Construction Engineer	3	
Contractor	141	
Cooper	1	
Cotton Compress	2	
Electrician	9	
Engineer	51	
Foundry	2	
Ginner	28	
Ice Manufacturer	8	
Iron and Steel Worker	4	
Laborer	16	
Linotypist	3	
Machinist	12	
Manufacturer	45	
Mason	2	
Mechanic	23	
Metal Worker	3	
Oil Mill Worker	5	
Painter	6	
Paperhanger	1	
Pattern Maker	1	
Plasterer	2	
Plumber	12	
Printer	28	
Sawfiler	1	
Seamstress	9	
Stationary Engineer	4	
Stone Cutter	2	
Tailor	9	
Tinner	1	
Toolmaker	1	
Upholsterer	1	
Woodworker	2	
Wool Sorter	1	
		321

Transportation:

Aviator	1	
Claim Adjuster	7	
Deliveryman	4	
Express Agent	3	
Pilot	2	
Railroad Employee	224	
Railroad Executive	6	
Seafaring	2	
Steamship Employee	4	
Street Car Employee	1	
Telegraph Employee	12	
Telephone Employee	18	
Truck Driver	10	
		294

Clerical:

Agent	10	
Bank Employee	1	
Bookkeeper	36	
Civil Service	9	
Collector	7	
Information Agency	2	
Recorder	1	
Secretary	24	
Stenographer	18	
		108

Trade:

Advertiser	9	
Auto Business	46	
Auto Loans	1	
Banker	119	
Broker	40	
Butcher	11	
Capitalist	9	
Cashier	11	
Clerk	45	
Coal Dealer	4	
Confectioner	8	
Cotton Buyer	36	
Cotton Classer	1	
Cotton Merchant	29	
Cotton Seed and Products	8	
Credit Association Employee	1	
Credit Man	5	
Creamery Manager	3	
Druggist	75	
Employment Bureau	1	
Estimator	2	
Executive	26	
Exporter	2	
Financier	7	
Foreman	7	
Fuel Dealer	2	
Furrier	1	
Garage Manager-Owner	20	
Gas and Filling Station	23	
Grain Dealer	12	
Grocer	67	
Huckster	2	
Ice Dealer	1	
Importer	3	
Inspector	3	
Insurance	140	
Investments	23	
Jeweler	24	
Jobber	6	
Junk Dealer	2	
Loans & Mortgages	11	
Manager	69	
Merchant	581	
Miller	11	
Milliner	4	
Motion Picture	1	
Nowsdealer	6	
Official Building and Loan Association	1	
Oil Business	189	
Oil Well Supplies	5	
Packer	1	
Produce Business	7	
Promoter	4	
Public Utility Employee	11	
Publisher	17	
Real Estate	178	
Refining	3	
Salesman	247	
Shipping Clerk	3	
Stone Dealer	4	
Storage	8	
Sugar Company Employee	1	
Theater	10	
Trader	2	
Undertaker	8	
Warehouse	2	
Wholesaler	46	
		2256

Public Service:

Agent, U. S. Custom Service	1	
Army Officer	35	
City Employee	34	
City Official	6	
Congressman	3	
County Employee	18	
County Official	39	
Diplomat	1	
District Clerk	3	
Government Employee	58	
Jailer	1	
Judge	21	
Postmaster	24	
Post Office Employee	76	
Ranger	1	
Sheriff	2	
State Service Employee	91	
Tax Collector	4	
United States Senator	1	
University Employee	22	
		441

Domestic & Personal Service:

Barber	30	
Beauty Specialist	2	
Boarding House	28	
Chaperon	1	
Cleaner	10	
Cook	2	
Dietitian	8	
Hatter	2	
Hotel Proprietor	25	
Housekeeper	31	
Housewife	182	
Janitor	1	
Landlord	23	
Laundryman	14	
Matron	1	
Restaurant Owner	25	
Rooming House	6	
Shoe Repairer	5	
Superintendent of Grounds	2	
Watchman	2	
		400

Professional:

Abstractor	9	
Accountant	35	
Architect	11	
Artist	7	
Auditor	26	
Chemist	5	
Christian Science Practitioner	1	
Civil Engineer	45	
Coach	2	
College President	2	
Court Reporter	4	
Dean	8	
Dentist	38	
Designer	4	
Draftsman	1	
Editor	15	
Electrical Engineer	16	
Entomologist	1	
Interior Decorator	2	
Journalist	3	
Laboratory Technician	1	
Lawyer	318	
Librarian	2	
Mechanical Engineer	2	
Mining Engineer	1	
Minister	98	
Missionary	3	
Musician	3	
Music Teacher	10	
Newspaperman	17	
Nurse	19	
Optician	7	
Pathologist	1	
Petroleum Engineer	2	
Pharmacist	20	
Photographer	4	
Physician	260	
Principal or Superintendent of High School	39	
Registrar	1	
Secretary, Chamber of Commerce	8	
Social Service Worker	7	
Statistician	1	
Superintendent	9	
Surveyor	5	
Teacher	236	
Veterinarian	1	
Writer	2	
Y.W.C.A.	3	
		1315

Miscellaneous:

Deceased	16	
Retired	42	
No Occupation	83	
Not Given	269	
Student	4	
Widow	3	
		417

TOTAL 6739

FIG. 51

Scholastic Performance of First-Year Freshmen of 1932-1933 Grouped According to Rank in High-School Graduating Class

Two types of freshman averages are given in this tabulation: (1) the average number of semester hours passed during the session, and (2) the average number of semester hours passed on a D-grade basis. The average on a "D-grade basis" means that all grades are reduced to the common denominator of D before the average is obtained.

	Total	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Rank Unknown
1. Average Number Semester Hours Passed:						
All Students:						
Men	23.1	26.9	23.0	21.0	16.6	18.4
Women	24.2	27.1	22.6	20.6	18.3	25.1
Both	23.4	27.0	22.8	20.9	17.0	20.0
College of Arts and Sciences:						
Men	23.7	27.4	23.4	22.3	17.9	18.8
Women	24.3	27.1	22.7	20.7	18.3	25.1
Both	23.9	27.3	23.1	21.8	18.0	20.6
College of Engineering:						
Men	21.1	25.4	21.7	14.8	12.7	16.9
Women	20.6	22.0	26.0	15.0	0.0	0.0
Both	21.1	25.3	21.8	14.7	12.7	16.9
College of Pharmacy:						
Men	14.8	30.0	22.4	13.5	4.4	0.0
Women	17.0	0.0	17.0	0.0	0.0	0.0
Both	15.0	30.0	20.9	13.5	4.4	0.0

FIG. 52

Scores Made by Freshmen Grouped by Secondary Schools from Which They Came

1932-1933

In this tabulation there is given the number of freshmen coming from each school, the number of semesters completed by full-time students from each school, and the score made by these full-time students.

In determining the score made by the students from each school, the following procedure was observed:

1. The score for each school represents the average number of semester hours passed per student on a D-grade basis.
2. Only completed semesters were counted. If a student withdrew during a semester, that semester of attendance was not counted.
3. Only full-time students were counted. By "full-time" student is meant a student who carried at least twelve semester hours of

School	Number of Students	Number of full-time Semesters Completed	Score
Galveston	21	39	31.3
Gatesville	1	2	15.0
Georgetown	4	6	32.8
Giddings	1	1	0.0
Gilmer	4	4	24.9
Gonzales	5	7	22.9
Goose Creek	6	8	20.0
Graham	1	2	23.3
Grand Saline	1	2	18.0
Granger	1	2	6.9
Grapeland	1	2	36.9
Greenville	6	9	26.7
Highland Park	20	37	29.5
Hillsboro	1	1	31.8
Hockaday School	3	5	21.1
Holding Institute	2	4	29.1
Hondo	5	6	28.1
Honey Grove	2	4	33.6
Houston	47	86	27.7
Reagan	4	8	25.4
Milby	1	2	34.4
Sam Houston	8	13	27.1
San Jacinto	34	63	27.9

FIG. 53

Use of Equipment by Other Departments

The Hollerith equipment is made available to any other department in the University which has need for it, and several divisions make use of it. It is used also for demonstration purposes before the various classes in statistics, and is available for use by graduate students in working out statistical problems.

PART II

Applications in the Registrar's Office

CHAPTER V

University of Oregon

By
CLIFFORD L. CONSTANCE
Assistant Registrar

PERMANENT records of students' academic work all too often are as static and inflexible as if cut in stone. They are excellent depositories of data but they are of slight direct value for analysis and summary purposes. At the University of Oregon, at least, our permanent records of students' work are simply sheets bearing written lists of courses carried and grades earned. In this age of inquiry and research they need supplementing with some record which can facilitate comparisons and analyses within and between individuals' records. It is for this purpose that we constructed and introduced a "Summary Tabulating Card." (See Figs. 54 and 55) described below as it has been revised after several years of experience in use. This card serves two large, related functions for us. First, it provides a cumulative current check on students' progress toward fulfilling the various academic requirements; this progress is simply written on the card and may not be punched into the card except for special purposes. Second, it permits the selection and study of student records on a great number of classifications, which are punched into the card. It is from this second function of the card that there follows its immense value in research. Slight modification, if desired, would fit it also for a complete record and directory card of alumni; our previous form of this card, for instance, provided space for addresses and family history subsequent to graduation from the University.

The Back of the Summary Card (Fig. 54)

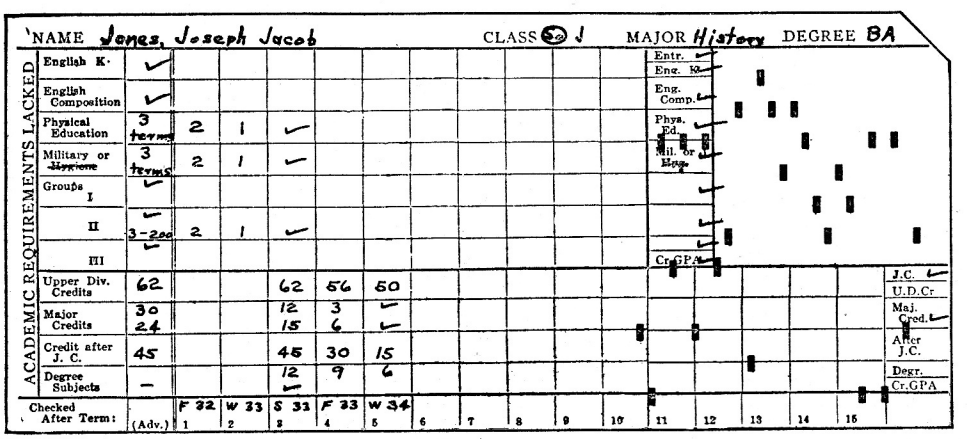


FIG. 54

After the close of each school term the permanent record of each student is completed and his Summary Card is rechecked to date. Our undergraduate academic requirements may be summarized briefly as follows:

Junior Certificate Requirements:

Entrance: Clear of conditions.
English K: Passing of entrance English examination or of Corrective English course.
English Composition: 9 term hours.
Physical Education: 6 terms.
Military Science: 6 terms for men.
General Hygiene: 3 terms for women.
Group Requirements: Prescribed amount of work selected from three "groups" representing comprehensive fields of knowledge, according to major.
Credits and Grade Point Average: 93 term hours, 1.00 GPA.

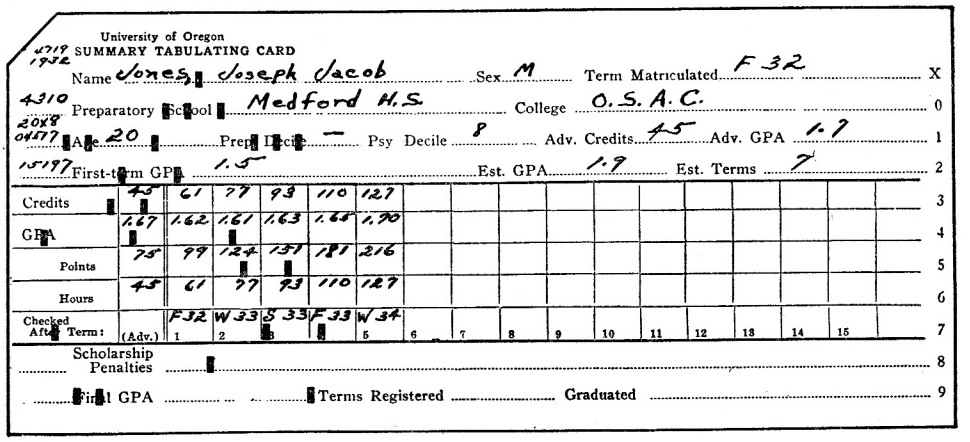
Graduation Requirements:

Junior Certificate: Earned.
Upper Division Credits: 45 or 62 term hours, according to major.
Major Credits: 36 (including 24 upper division) term hours in the major.
Credits After Junior Certificate: 45 term hours.
Degree Subjects: Prescribed subjects, according to degree sought.
Credits and Grade Point Average: 186 term hours, 1.00 GPA.

The top three-fifths of the back of the card, it is apparent, is devoted to Junior Certificate requirements and the bottom portion to graduation requirements. The status of different requirements as listed at the left is checked term by term in each row across the card; when completely fulfilled, the requirements are checked off in the column at the extreme right. "Entrance," "Credits and Grade Point Average," and "Junior Certificate" are checked only when satisfactory and therefore need not be carried along from term to term in separate rows. The illustration shown is a student who entered the University as a sophomore, completed his Junior Certificate requirements during the first year here, and has now completed two terms in the upper division. He is working toward a Bachelor of Arts degree, with a major in History. It may be noted that his record has been checked for five terms in the University, that all his Junior Certificate and his Major Credits requirements are fulfilled. It is possible at a glance to tell this student what work he still needs to qualify for graduation and for the B.A. degree; when all the graduation requirements are checked off at the right he will be so qualified. The blank corner at the upper right may be used for supplementary checking, such as that for a teaching certificate.

We have used this information principally as a part of office routine and for ready reference, and have not punched it into the card for mechanical sorting. Very obviously this would be simple to do if it were desired. The data we do punch are shown on the face of the card.

The Front of the Summary Card (Fig. 55)



University of Oregon
SUMMARY TABULATING CARD

Name Jones, Joseph Jacob Sex M Term Matriculated F 32

Preparatory School Medford H.S. College O.S.A.C.

Age 20 Prep Decile — Psy Decile 8 Adv. Credits 45 Adv. GPA 1.7

First-term GPA 1.5 Est. GPA 1.9 Est. Terms 7

Credits	45	61	77	93	110	127											
GPA	1.67	1.62	1.61	1.63	1.65	1.70											
Points	75	99	124	151	181	216											
Hours	45	61	77	93	110	127											
Checked After Term:	(Adv.) F32	W33	S33	F33	W34	6	7	8	9	10	11	12	13	14	15		
	1	2	3	4	5												

Scholarship Penalties

Final GPA Terms Registered Graduated

FIG. 55

The front of the Summary Card is more typical of a tabulating card, except for a cumulative term by term grade record which is related to the information on the back of the card but is removed from there to avoid congestion and resultant punching of holes into rows of written data. The other items on the face of the card are those which are used in personnel research and in analytical studies of various types. They are coded at the left end of each row, and punched for mechanical sorting. All data shown above the grade record assume permanent values not later than the end of the first term in the University. Therefore they may be punched as the permanent bases for an infinite variety of segregations and studies.

We are now in process of preparing a detailed report to each high-school principal in the state of Oregon, listing all of his former students who have come to the University during a certain period (sorting by school and matriculation date, and alphabetizing names), together with their personnel data and scholastic achievement. One particularly interesting research project for which we have used these data leads to regression equations for estimating grade point average and terms of attendance; this project has been based upon a total group of nearly 5000 students, and we consider it to be of great importance. Incidentally over 100 product-moment zero-order intercorrelations were computed in the process of this study, and the Hollerith technique immensely facilitated segregation of data for the correlation charts. The convenience of this method is illustrated by the sample chart (Fig. 56), (a simplified type, only 8½ by 11 inches in size, developed by the Psychology Department of the University). The 1983 cases included here were sorted first by columns (terms), then by rows (GPA) within columns, and the appropriate number of cases written directly in each cell of the chart. Errors of hand tabulation were avoided, and we found a simple way to check the accuracy of summations. Also an indefinitely large number might be written in each cell instead of the mere twenty cases possible with hand tallying.

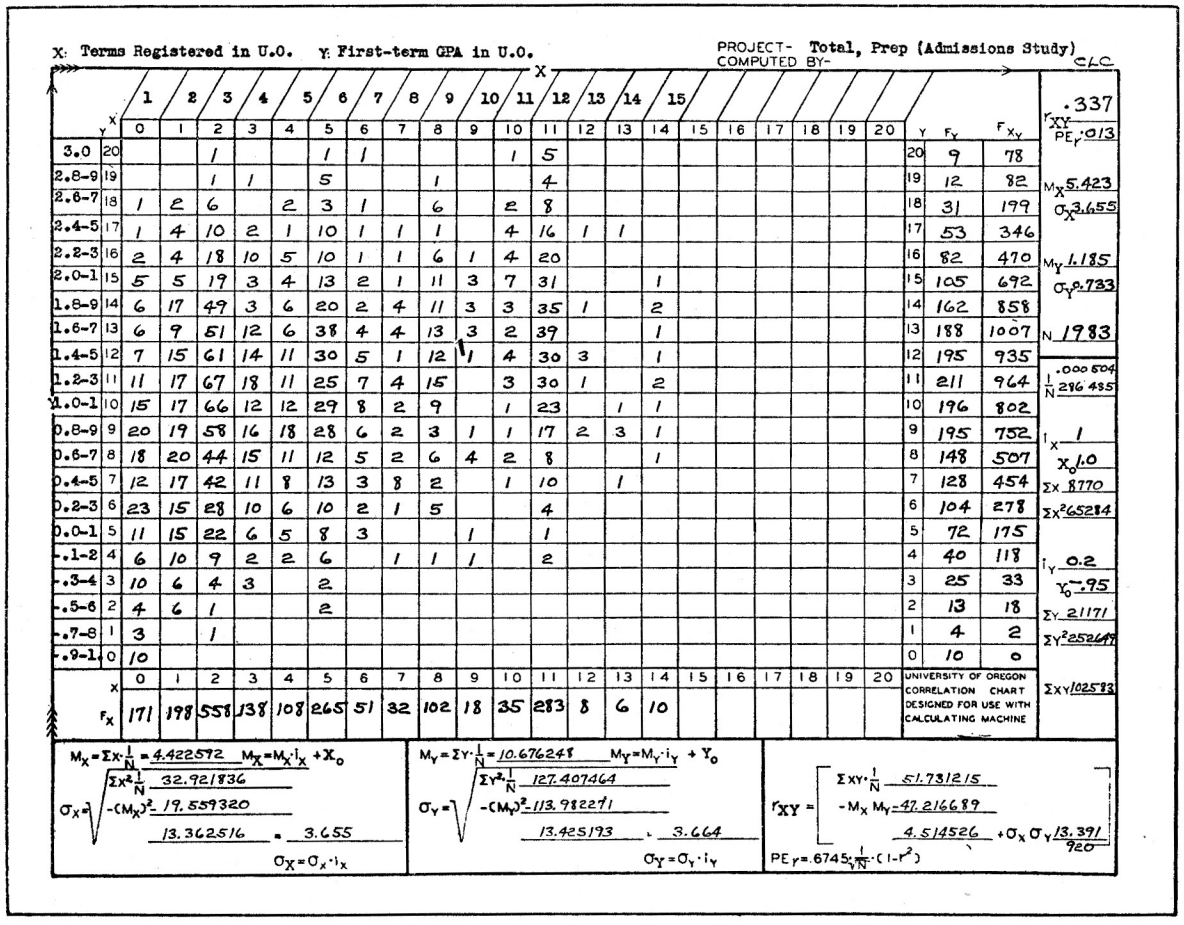


FIG. 56—Sample Correlation Chart

Codes

Our codes, for reducing data to numerical digits for punching and sorting, of course, are especially adapted to the University of Oregon. We have just completed a four-digit, 10,000-division code for proper names which we expect will almost perfectly alphabetize our enrollment of 2500 students. Previously we had used a three-digit code but found it inadequate for complete alphabetizing: in one group numbering 1346, for example, 372 students were coded the same as one or more others, and the duplication ran as high as eight individuals with the same code number. The skeleton of the four-digit code consists of nearly all possible three-letter combinations; this detail was restricted for Q and X and a few other unusual combinations, but all were included which appear in the New York or the Portland telephone directories. Approximately two-thirds of the 10,000 divisions were thus determined; and further interpolations beyond the third letter and into common proper names and their initials were made by inspection of frequencies in the University's own file of some 40,000 student names. (The complete name code described above appears as an appendix, on pages 67 to 90.

Codes for other data on the Summary Card are as follows (X or blank used for none or unknown):

Sex:
1 Male
2 Female

Term Matriculated (similar to a month code):
9 Fall Term
1 Winter Term
4 Spring Term
Last two digits for year (32 for 1932)

Preparatory School and *College:*
Two-digit code for each, especially detailing Oregon and other Pacific Coast schools

Age at Matriculation:
Two digits, directly to nearest year

Prep. (*Preparatory*) *Decile:*
One digit (0 for Tenth), directly from our empirical equating of preparatory-school grade scales

Psy. (*Psychological*) *Decile:*
One digit, from score on American Council on Education Psychological Examination

Advanced Credits at Matriculation:
Three digits, directly

Grade Point Averages (*GPA*):
Two digits (9 for Minus), to one decimal place

Terms:
One digit (0 for Ten, X for Eleven, Y for Twelve), directly

Scholarship Penalties at University of Oregon:

1 Probation
2 Disqualification
3 Both Probation and Disqualification

Graduated from University of Oregon:

0 No
1 Yes

Other Cards

As we have said, our Summary Card serves these two principal purposes: (1) a convenient summary of academic record, and (2) a powerful summary of data for personnel and academic research. The original use for Hollerith equipment at this University was to aid in the compiling of statistical reports and of lists and directories. This use continues undiminished, although our techniques change frequently. For this purpose we now are using a "Statistical Tabulating Card," (Fig. 57) with a "Registrar's Data Card" (Fig. 58) for accumulating part of the necessary data for it. These cards are made with stubs for binding in each student's booklet of registration forms and are filled out by him, the former once a year and the latter but once during his University career. The Summary Card (see Figs. 54 and 55) on the other hand, is made out in the Registrar's Office and is always retained there. Permanent information supplied on the Data Card is coded on the margin of the same card and punched into the first 35 columns of the Statistical Card. The latter bears a written record of changeable information with values as of one specified academic year, which information is punched into the remaining 45 columns. Enrollment reports (by sex, class, major, matriculation date; by session, and excluding duplicates between sessions), tables of personnel data (age, ability measures, self-support, etc.), lists of students and parents by home addresses—these are a few examples of the wide usefulness of this Statistical Card. But it is a different usefulness from that of the Summary Card.

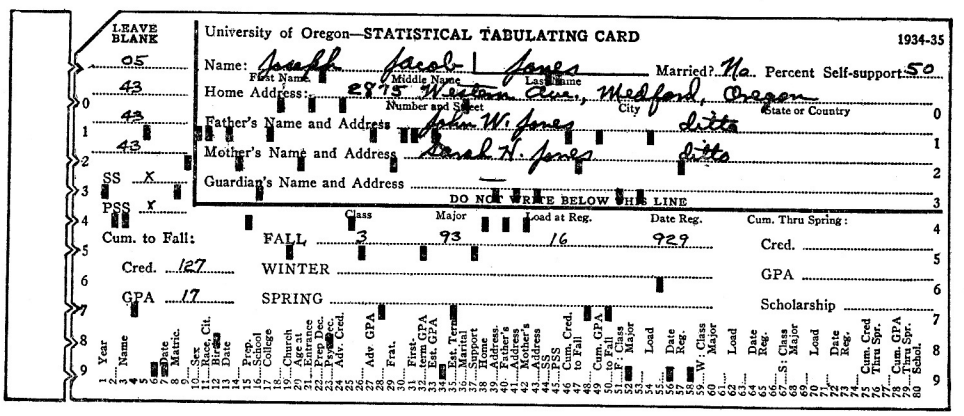
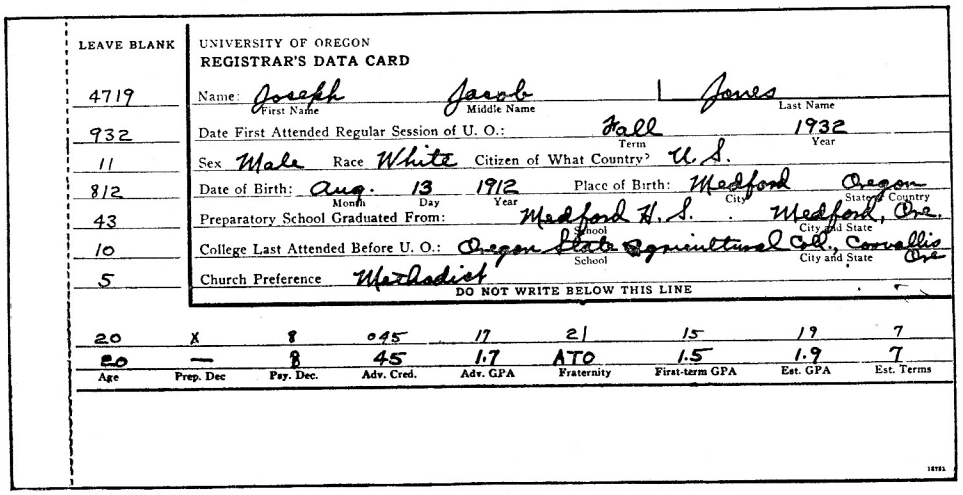


FIG. 57



LEAVE BLANK

UNIVERSITY OF OREGON
REGISTRAR'S DATA CARD

4719 Name: Joseph (First Name) Jacob (Middle Name) Jones (Last Name)

932 Date First Attended Regular Session of U. O.: Fall (Term) 1932 (Year)

11 Sex Male Race White Citizen of What Country? U. S.

812 Date of Birth: Aug. (Month) 13 (Day) 1912 (Year) Place of Birth: Medford (City) Oregon (State or Country)

43 Preparatory School Graduated From: Medford H. S. (School) Medford, Ore. (City and State)

10 College Last Attended Before U. O.: Oregon State Agricultural Col. (School) Corvallis Ore (City and State)

5 Church Preference Methodist

DO NOT WRITE BELOW THIS LINE

20	X	8	045	17	21	15	19	7
20	—	8	45	1.7	ATO	1.5	1.9	7
Age	Prep. Dec	Pay. Dec.	Adv. Cred.	Adv. GPA	Fraternity	First-term GPA	Est. GPA	Est. Terms

FIG. 58

Conclusion

The Summary Tabulating Card we have described is designed with details for our particular situation at the University of Oregon. Academic requirements of other schools of course are different from ours but progress toward meeting them can be checked by the procedure described with this card. The factors we have used in personnel research (those appearing on the face of the card) have been selected after nearly ten years of experiments at the University, particularly by Dr. Howard R. Taylor in the Bureau of Personnel Research. Other schools may prefer to use different data and various statistical techniques. But the significant feature of this card is that a minimum of duplication supplements the fixed record with a flexible and active tool. Admittedly we still are experimenting with it, and with the other cards mentioned. But we believe the Summary Card fills a unique place by facilitating ready analysis of a student's academic record and his more permanent personal characteristics. Certainly if education is to be fitted to the student such study is fundamental. And on this card the data of our static permanent records are electrified for these dynamic functions.

APPENDIX TO PART II

Applications in the Registrar's Office

CHAPTER V

University of Oregon

A 10,000 division code for proper names

Aaa	0000	Adams C	0084	Afr	0167	Aiw	0250	Allen H	0333
Aab	0001	" D	0085	Afs	0168	Aix	0251	" I	0334
Aac	0002	" E	0086	Aft	0169	Aiy	0252	" J	0335
Aad	0003	" F	0087			Aiz	0253	" K	0336
Aae	0004	" G	0088	Afu	0170	Aja	0254	" L	0337
Aaf	0005	" H	0089	Afv	0171	Ajb	0255	" M	0338
Aag	0006			Afw	0172	Ajc	0256	" N	0339
Aah	0007	" J	0090	Afx	0173	Ajd	0257		
Aai	0008	" L	0091	Afy	0174	Aje	0258	" O	0340
Aaj	0009	" M	0092	Afz	0175	Ajf	0259	" P	0341
		" N	0093	Aga	0176			" R	0342
Aak	0010	" R	0094	Agb	0177	Ajg	0260	" S	0343
Aal	0011	" S	0095	Agc	0178	Ajh	0261	" T	0344
Aam	0012	" T	0096	Agd	0179	Aji	0262	" V	0345
Aan	0013	" W	0097			Ajj	0263	" W	0346
Aao	0014	Adamsa	0098	Age	0180	Ajk	0264	Alli	0347
Aap	0015	Adb	0099	Agf	0181	Ajl	0265	Allm	0348
Aaq	0016			Agg	0182	Ajm	0266	Alm	0349
Aar	0017	Adc	0100	Agh	0183	Ajn	0267		
Aas	0018	Add	0101	Agi	0184	Ajo	0268	Aln	0350
Aat	0019	Ade	0102	Agj	0185	Ajp	0269	Alo	0351
		Adf	0103	Agk	0186			Alp	0352
Aau	0020	Adg	0104	Agl	0187	Ajq	0270	Alq	0353
Aav	0021	Adh	0105	Agm	0188	Ajr	0271	Alr	0354
Aaw	0022	Adi	0106	Agn	0189	Ajs	0272	Als	0355
Aax	0023	Adj	0107			Ajt	0273	Alt	0356
Aay	0024	Adk	0108	Ago	0190	Aju	0274	Alu	0357
Aaz	0025	Adl	0109	Agp	0191	Ajv	0275	Alv	0358
Aba	0026			Agq	0192	Ajw	0276	Alw	0359
Abb	0027	Adm	0110	Agr	0193	Ajx	0277		
Abbo	0028	Adn	0111	Ags	0194	Ajy	0278	Alx	0360
Abc	0029	Ado	0112	Agt	0195	Ajz	0279	Aly	0361
		Adp	0113	Agu	0196			Alz	0362
Abd	0030	Adq	0114	Agv	0197	Aka	0280	Ama	0363
Abe	0031	Adr	0115	Agw	0198	Akb	0281	Amb	0364
Abf	0032	Ads	0116	Agx	0199	Akc	0282	Amc	0365
Abg	0033	Adt	0117			Akd	0283	Amd	0366
Abh	0034	Adu	0118	Agy	0200	Ake	0284	Ame	0367
Abi	0035	Adv	0119	Agz	0201	Akf	0285	Amf	0368
Abj	0036			Aha	0202	Akg	0286	Amg	0369
Abk	0037	Adw	0120	Ahb	0203	Akh	0287		
Abl	0038	Adx	0121	Ahc	0204	Aki	0288	Amh	0370
Abm	0039	Ady	0122	Ahd	0205	Akj	0289	Ami	0371
		Adz	0123	Ahe	0206			Amj	0372
Abn	0040	Aea	0124	Ahf	0207	Akk	0290	Amk	0373
Abo	0041	Aeb	0125	Ahg	0208	Akl	0291	Aml	0374
Abp	0042	Aec	0126	Ahh	0209	Akm	0292	Amm	0375
Abq	0043	Aed	0127			Akn	0293	Amn	0376
Abr	0044	Aee	0128	Ahi	0210	Ako	0294	Amo	0377
Abram	0045	Aef	0129	Ahj	0211	Akp	0295	Amp	0378
Abs	0046			Ahk	0212	Akq	0296	Amq	0379
Abt	0047	Aeg	0130	Ahl	0213	Akr	0297		
Abu	0048	Aeh	0131	Ahm	0214	Aks	0298	Amr	0380
Abv	0049	Aei	0132	Ahn	0215	Akt	0299	Ams	0381
		Aej	0133	Aho	0216			Amt	0382
Abw	0050	Aek	0134	Ahp	0217	Aku	0300	Amu	0383
Abx	0051	Ael	0135	Ahq	0218	Akv	0301	Amv	0384
Aby	0052	Aem	0136	Ahr	0219	Akw	0302	Amw	0385
Abz	0053	Aen	0137			Akx	0303	Amx	0386
Aca	0054	Aeo	0138	Ahs	0220	Aky	0304	Amy	0387
Acb	0055	Aep	0139	Aht	0221	Akz	0305	Amz	0388
Acc	0056			Ahu	0222	Ala	0306	Ana	0389
Acd	0057	Aeq	0140	Ahv	0223	Alb	0307		
Ace	0058	Aer	0141	Ahw	0224	Albi	0308	Anb	0390
Acf	0059	Aes	0142	Ahx	0225	Alc	0309	Anc	0391
		Aet	0143	Ahy	0226			And	0392
Acg	0060	Aeu	0144	Ahz	0227	Ald	0310	Ande	0393
Ach	0061	Aev	0145	Aia	0228	Aldr	0311	Anderson A	0394
Aci	0062	Aew	0146	Aib	0229	Ale	0312	" B	0395
Acj	0063	Aex	0147			Alexander A	0313	" C	0396
Ack	0064	Aey	0148	Aic	0230	" E	0314	" D	0397
Acl	0065	Aez	0149	Aid	0231	" H	0315	" E	0398
Acm	0066			Aie	0232	" L	0316	" F	0399
Acn	0067	Afa	0150	Aif	0233	" R	0317		
Aco	0068	Afb	0151	Aig	0234	Alf	0318	" G	0400
Acp	0069	Afc	0152	Aih	0235	Alg	0319	" H	0401
		Afd	0153	Aii	0236			" I	0402
Acq	0070	Afe	0154	Aij	0237	Alh	0320	" J	0403
Acr	0071	Aff	0155	Aik	0238	Ali	0321	" K	0404
Acs	0072	Afg	0156	Ail	0239	Alj	0322	" L	0405
Act	0073	Afh	0157			Alk	0323	" M	0406
Acu	0074	Afi	0158	Aim	0240	All	0324	" N	0407
Acv	0075	Afj	0159	Ain	0241	Alle	0325	" O	0408
Acw	0076			Aio	0242	Allen A	0326	" P	0409
Acx	0077	Afk	0160	Aip	0243	" B	0327		
Acy	0078	Afl	0161	Aiq	0244	" C	0328	" R	0410
Acz	0079	Afm	0162	Air	0245	" D	0329	" S	0411
		Afn	0163	Ais	0246			" T	0412
Ada	0080	Afo	0164	Ait	0247	" E	0330	" V	0413
Adam	0081	Afp	0165	Aiu	0248	" F	0331	" W	0414
Adams A	0082	Afq	0166	Aiv	0249	" G	0332	Andl	0415
" B	0083								

Andr 0416
Andrews A 0417
" E 0418
" H 0419
" L 0420
" R 0421
Andri 0422
Ane 0423
Anf 0424
Ang 0425
Anh 0426
Ani 0427
Anj 0428
Ank 0429
Anl 0430
Anm 0431
Ann 0432
Ano 0433
Anp 0434
Anq 0435
Anr 0436
Ans 0437
Ant 0438
Anu 0439
Anv 0440
Anw 0441
Anx 0442
Any 0443
Anz 0444
Aoa 0445
Aob 0446
Aoc 0447
Aod 0448
Aoe 0449
Aof 0450
Aog 0451
Aoh 0452
Aoi 0453
Aoj 0454
Aok 0455
Aol 0456
Aom 0457
Aon 0458
Aoo 0459
Aop 0460
Aoq 0461
Aor 0462
Aos 0463
Aot 0464
Aou 0465
Aov 0466
Aow 0467
Aox 0468
Aoy 0469
Aoz 0470
Apa 0471
Apb 0472
Apc 0473
Apd 0474
Ape 0475
Apf 0476
Apg 0477
Aph 0478
Api 0479
Apj 0480
Apk 0481
Apl 0482
Apm 0483
Apn 0484
Apo 0485
App 0486
Applegate 0487
Appli 0488
Apq 0489
Apr 0490
Aps 0491
Apt 0492
Apu 0493
Apv 0494
Apw 0495
Apx 0496
Apy 0497
Apz 0498
Aq 0499
Ara 0500
Arb 0501
Arc 0502
Ard 0503
Are 0504
Arf 0505
Arg 0506
Arh 0507
Ari 0508
Arj 0509
Ark 0510
Arl 0511
Arm 0512
Armi 0513
Arms 0514
Armstrong 0515
Armt 0516
Arn 0517
Arnold 0518
Arnole 0519
Aro 0520
Arp 0521
Arq 0522
Arr 0523
Ars 0524
Art 0525
Aru 0526
Arv 0527
Arw 0528
Arx 0529
Ary 0530
Arz 0531
Asa 0532
Asb 0533
Asc 0534
Asd 0535
Ase 0536
Asf 0537
Asg 0538
Ash 0539
Ashl 0540
Asi 0541
Asj 0542
Ask 0543
Asl 0544
Asm 0545
Asn 0546
Aso 0547
Asp 0548
Asq 0549
Asr 0550
Ass 0551
Ast 0552
Asu 0553
Asv 0554
Asw 0555
Asx 0556
Asy 0557
Asz 0558
Ata 0559
Atb 0560
Atc 0561
Atd 0562
Ate 0563
Atf 0564
Atg 0565
Ath 0566
Ati 0567
Atj 0568
Atk 0569
Atki 0570
Atkinson 0571
Atkint 0572
Atl 0573
Atm 0574
Atn 0575
Ato 0576
Atp 0577
Atq 0578
Atr 0579
Ats 0580
Att 0581
Atu 0582
Atv 0583
Atw 0584
Atx 0585
Aty 0586
Atz 0587
Aua 0588
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		Davidson	A	1742	Dg	1825	Dou	1908	Dya	1991
Cuw	1660	"	E	1743	Dha	1826	Doug	1909	Dyb	1992
Cux	1661	"	H	1744	Dhe	1827			Dyc	1993
Cuy	1662	"	L	1745	Dhi	1828	Douglas	1910	Dyd	1994
Cuz	1663	"	R	1746	Dhl	1829	Douglass	1911	Dye	1995
Cv	1664	Davie		1747			Dougle	1912	Dyf	1996
Cw	1665	Davies		1748	Dho	1830	Doum	1913	Dyg	1997
Cx	1666	Davis	A	1749	Dhr	1831	Dov	1914	Dyh	1998
Cya	1667				Dhu	1832	Dow	1915	Dyi	1999
Cyb	1668	"	B	1750	Dhw	1833	Dowd	1916		
Cyc	1669	"	C	1751	Dhy	1834	Down	1917	Dyj	2000
		"	D	1752	Dia	1835	Downing	1918	Dyk	2001
Cyd	1670	"	E	1753	Dib	1836	Downs	1919	Dyl	2002
Cye	1671	"	F	1754	Dic	1837			Dym	2003
Cyf	1672	"	G	1755	Dick	1838	Dox	1920	Dyn	2004
Cyg	1673	"	H	1756	Dicke	1839	Doy	1921	Dyo	2005
Cyh	1674	"	I	1757			Doz	1922	Dyp	2006
Cyi	1675	"	J	1758	Dickey	1840	Dp	1923	Dyq	2007
Cyj	1676	"	K	1759	Dicki	1841	Dq	1924	Dyr	2008
Cyk	1677				Dickson	1842	Dra	1925	Dys	2009
Cyl	1678	"	L	1760	Did	1843	Drake	1926		
Cym	1679	"	M	1761	Die	1844	Dran	1927	Dyt	2010
		"	N	1762	Dier	1845	Dre	1928	Dyu	2011
Cyn	1680	"	O	1763	Dif	1846	Drew	1929	Dyv	2012
Cyo	1681	"	P	1764	Dig	1847			Dyw	2013
Cyp	1682	"	R	1765	Dih	1848	Drh	1930	Dyx	2014
Cyq	1683	"	S	1766	Dii	1849	Dri	1931	Dyy	2015
Cyr	1684	"	T	1767			Dris	1932	Dyz	2016
Cys	1685	"	V	1768	Dij	1850	Dro	1933	Dz	2017
Cyt	1686	"	W	1769	Dik	1851	Dru	1934	Eaa	2018
Cyu	1687				Dil	1852	Drv	1935	Eab	2019
Cyv	1688	Davise		1770	Dillard	1853	Dry	1936		
Cyw	1689	Daw		1771	Dille	1854	Drz	1937	Eac	2020
		Daws		1772	Dillo	1855	Ds	1938	Ead	2021
Cyx	1690	Dawson		1773	Dim	1856	Dt	1939	Eae	2022
Cyy	1691	Dax		1774	Dimm	1857			Eaf	2023
Cyz	1692	Day	A	1775	Din	1858	Dua	1940	Eag	2024
Cza	1693	"	E	1776	Dio	1859	Dub	1941	Eah	2025
Cze	1694	"	H	1777			Duc	1942	Eai	2026
Czh	1695	"	L	1778	Dip	1860	Dud	1943	Eaj	2027
Czi	1696	"	R	1779	Diq	1861	Due	1944	Eak	2028
Czl	1697				Dir	1862	Duf	1945	Eal	2029
Czm	1698	Dayt		1780	Dis	1863	Dug	1946		
Czn	1699	Daz		1781	Dit	1864	Duh	1947	Eam	2030
		Db		1782	Diu	1865	Dui	1948	Ean	2031
Czo	1700	Dc		1783	Div	1866	Duj	1949	Eao	2032
Czr	1701	Dd		1784	Diw	1867			Eap	2033
Czu	1702	Dea		1785	Dix	1868	Duk	1950	Eaq	2034
Czv	1703	Dean		1786	Dixon	1869	Dul	1951	Ear	2035
Czw	1704	Dear		1787			Dum	1952	Eas	2036
Czy	1705	Deb		1788	Diy	1870	Dun	1953	East	2037
Czz	1706	Dec		1789	Diz	1871	Duncan	1954	Easth	2038
Daa	1707				Dj	1872	Dund	1955	Eastm	2039
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Dac	1709	Dee		1791	Dl	1874	Duni	1957	Eat	2040
		Def		1792	Dm	1875	Dunlap	1958	Eaton	2041
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Dag	1713	Dej		1796	Dobi	1879	"	E 1961	Eax	2045
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		Dem		1802	Dof	1885	Dup	1968	Ebd	2051
Dalt	1720	Demi		1803	Dog	1886	Duq	1969	Ebe	2052
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Dams	1723	Denn		1806	Doj	1889	Durh	1971	Ebg	2055
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Dank	1727				Doll	1892	Duu	1975	Ebk	2059
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Dap	1729	Deq		1811	Don	1894	Duw	1977	Ebl	2060
		Der		1812	Donal	1895	Dux	1978	Ebm	2061
Daq	1730	Derl		1813	Done	1896	Duy	1979	Ebn	2062
Dar	1731	Des		1814	Dono	1897			Ebo	2063
Dark	1732	Det		1815	Doo	1898	Duz	1980	Ebp	2064
Darn	1733	Deu		1816	Dop	1899	Dv	1981	Ebq	2065
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Dau	1737				Dorm	1902	Dwi	1985	Ebu	2069
Dav	1738	Dew		1820	Dorr	1903	Dwo	1986		
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		Dey		1822	Dors	1905	Dwu	1988	Ebw	2071
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" L	7142	Puy	7232	Rae	7322	Rey	7412	" N	7502
" R	7143	Puz	7233	Raf	7323	Reynolds A	7413	" R	7503
Portera	7144	Pv	7234	Rag	7324	" E	7414	" S	7504
Pos	7145	Pw	7235	Rah	7325	" H	7415	" T	7505
Post	7146	Px	7236	Rai	7326	" L	7416	" W	7506
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Potter	7148	Pyb	7238	Rak	7328	Rez	7418	" E	7508
Pottera	7149	Pyc	7239	Ral	7329	Rf	7419	" H	7509
Pou	7150	Pyd	7240	Ram	7330	Rg	7420	" L	7510
Pov	7151	Pye	7241	Ramm	7331	Rha	7421	" R	7511
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Powell A	7153	Pyg	7243	Ran	7333	Rhi	7423	Robin	7513
" C	7154	Pyh	7244	Randall	7334	Rho	7424	Robinson A	7514
" E	7155	Pyi	7245	Randl	7335	Rhod	7425	" B	7515
" F	7156	Pyj	7246	Rank	7336	Rhu	7426	" C	7516
" H	7157	Pyk	7247	Rankin	7337	Rhy	7427	" D	7517
" J	7158	Pyl	7248	Rann	7338	Ria	7428	" E	7518
" L	7159	Pym	7249	Rao	7339	Rib	7429	" F	7519
" N	7160	Pyn	7250	Rap	7340	Ric	7430	" G	7520
" S	7161	Pyo	7251	Raq	7341	Rice A	7431	" H	7521
Powers A	7162	Pyp	7252	Rar	7342	" C	7432	" J	7522
" E	7163	Pyq	7253	Ras	7343	" E	7433	" L	7523
" H	7164	Pyr	7254	Rasm	7344	" F	7434	" M	7524
" L	7165	Pys	7255	Rasmussen	7345	" H	7435	" N	7525
" R	7166	Pyt	7256	Raso	7346	" J	7436	" R	7526
Pox	7167	Pyu	7257	Rat	7347	" L	7437	" S	7527
Poy	7168	Pyv	7258	Rau	7348	" N	7438	" T	7528
Poz	7169	Pyw	7259	Rav	7349	" S	7439	" W	7529
Pp	7170	Pyx	7260	Raw	7350	Rich	7440	Robinsona	7530
Pq	7171	Pyy	7261	Rax	7351	Richards	7441	Robis	7531
Pra	7172	Pyz	7262	Ray	7352	Richardson	7442	Robn	7532
Pras	7173	Pz	7263	Rayb	7353	Riche	7443	Roc	7533
Prat	7174	Qa	7264	Raym	7354	Richm	7444	Rod	7534
Pratt	7175	Qb	7265	Raz	7355	Richo	7445	Rodg	7535
Pre	7176	Qc	7266	Rb	7356	Rick	7446	Rodl	7536
Pres	7177	Qd	7267	Rc	7357	Ricke	7447	Roe	7537
Prest	7178	Qe	7268	Rd	7358	Rid	7448	Rof	7538
Pret	7179	Qf	7269	Rea	7359	Ridd	7449	Rog	7539
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" C	7183	Qj	7273	Rear	7363	Riel	7453	" E	7543
" E	7184	Qk	7274	Reb	7364	Rif	7454	" F	7544
" F	7185	Ql	7275	Rec	7365	Rig	7455	" H	7545
" H	7186	Qm	7276	Red	7366	Rih	7456	" J	7546
" J	7187	Qn	7277	Redi	7367	Rii	7457	" L	7547
" L	7188	Qo	7278	Ree	7368	Rij	7458	" N	7548
" N	7189	Qp	7279	Reed A	7369	Rik	7459	" S	7549
" S	7190	Qq	7280	" C	7370	Ril	7460	Rogg	7550
Prich	7191	Qr	7281	" E	7371	Rile	7461	Roh	7551
Prie	7192	Qs	7282	" F	7372	Riley	7462	Roi	7552
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Prit	7194	Qua	7284	" J	7374	Rin	7464	Rok	7554
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Pross	7200	Qug	7290	Reese	7380	Riq	7470	Rop	7560
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Prv	7202	Qui	7292	Reeves	7382	Ris	7472	Ror	7562
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" C	7575	Ryj	7665	Schwar	7755	Shel	7845	" D	7935
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" E	7577	Ryl	7667	Schwe	7757	Shelle	7847	" F	7937
" F	7578	Rym	7668	Sci	7758	Shelt	7848	" G	7938
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" H	7580	Ryo	7670	Scl	7760	Sheph	7850	" I	7940
" J	7581	Ryp	7671	Scm	7761	Sher	7851	" J	7941
" L	7582	Ryq	7672	Scn	7762	Sheridan	7852	" K	7942
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" N	7584	Rys	7674	Scott A	7764	Sherman	7854	" M	7944
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" S	7586	Ryu	7676	" C	7766	Sherr	7856	" O	7946
" T	7587	Ryv	7677	" D	7767	Sherw	7857	" P	7947
" W	7588	Ryw	7678	" E	7768	Sherwood	7858	" R	7948
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Rowle	7598	Saf	7688	" T	7778	Shin	7868	Six	7958
Rox	7599	Sag	7689	" W	7779	Ship	7869	Sly	7959
Roy	7600	Sah	7690	Scotta	7780	Shir	7870	Siz	7960
Roz	7601	Sai	7691	Scou	7781	Shis	7871	Sj	7961
Rp	7602	Saint	7692	Scr	7782	Shj	7872	Ska	7962
Rq	7603	Saj	7693	Scu	7783	Shk	7873	Ske	7963
Rr	7604	Sak	7694	Scv	7784	Shl	7874	Skel	7964
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Ruj	7616	Sao	7706	See	7796	Sht	7886	Skw	7976
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Rul	7618	Saq	7708	Sef	7798	Shul	7888	Skz	7978
Rum	7619	Sar	7709	Seg	7799	Shum	7889	Sla	7979
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Ruo	7622	Sau	7712	Sej	7802	Shx	7892	Sle	7982
Rup	7623	Saunders	7713	Sek	7803	Shy	7893	Sli	7983
Ruq	7624	Saur	7714	Sel	7804	Shz	7894	Slo	7984
Rur	7625	Sav	7715	Sell	7805	Sia	7895	Sloc	7985
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" E	7630	Say	7720	Seq	7810	Sieg	7900	Smi	7990
" F	7631	Saz	7721	Ser	7811	Siegr	7901	Smit	7991
" H	7632	Sb	7722	Ses	7812	Sif	7902	Smith A	7992
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" L	7634	Sce	7724	Seu	7814	Sih	7904	" C	7994
" N	7635	Sch	7725	Sev	7815	Sii	7905	" D	7995
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Spat	8058	" F	8148	Suz	8238	Tax	8328	" C	8418
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Spee	8060	" H	8150	Sve	8240	Taylor A	8330	" E	8420
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" L	8065	" R	8155	Svy	8245	" F	8335	" J	8425
" R	8066	" S	8156	Swa	8246	" G	8336	" K	8426
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Sph	8068	" W	8158	Swanson	8248	" I	8338	" M	8428
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Spl	8071	Stid	8161	Swe	8251	" L	8341	" P	8431
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Spo	8074	Stim	8164	Swen	8254	" O	8344	" T	8434
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Spr	8076	Stj	8166	Swh	8256	" R	8346	" W	8436
Spre	8077	Stm	8167	Swi	8257	" S	8347	Thoms	8437
Spri	8078	Stn	8168	Swig	8258	" T	8348	Thor	8438
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Spw	8082	Stoddard	8172	Swy	8262	Taz	8352	Thr	8442
Spy	8083	Stoe	8173	Sx	8263	Tb	8353	Thu	8443
Sq	8084	Stol	8174	Sya	8264	Tc	8354	Thur	8444
Sra	8085	Stone A	8175	Syb	8265	Td	8355	Thurs	8445
Sre	8086	" E	8176	Syc	8266	Tea	8356	Thw	8446
Srh	8087	" H	8177	Syd	8267	Teb	8357	Thy	8447
Sri	8088	" L	8178	Sye	8268	Tec	8358	Tia	8448
Srm	8089	" R	8179	Syf	8269	Ted	8359	Tib	8449
Srn	8090	Stoneb	8180	Syg	8270	Tee	8360	Tic	8450
Sro	8091	Stor	8181	Syh	8271	Tef	8361	Tid	8451
Srs	8092	Store	8182	Syi	8272	Teg	8362	Tie	8452
Sru	8093	Stot	8183	Syj	8273	Teh	8363	Tif	8453
Sry	8094	Stou	8184	Syk	8274	Tej	8364	Tig	8454
Ss	8095	Stov	8185	Syl	8275	Tej	8365	Tih	8455
Sta	8096	Str	8186	Sym	8276	Tek	8366	Tii	8456
Stad	8097	Strai	8187	Syn	8277	Tel	8367	Tij	8457
Staf	8098	Stran	8188	Syo	8278	Tem	8368	Tik	8458
Stag	8099	Stras	8189	Syp	8279	Temp	8369	Til	8459
Stal	8100	Strau	8190	Syq	8280	Templeton	8370	Till	8460
Stall	8101	Straus	8191	Syr	8281	Tempo	8371	Tim	8461
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Stant	8106	Stroo	8196	Syw	8286	Teq	8376	Tir	8466
Stap	8107	Strou	8197	Syx	8287	Ter	8377	Tis	8467
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Tj	8475	" E	8565	Ubo	8655	Uhx	8745	Upd	8835
Tk	8476	" H	8566	Ubp	8656	Uhy	8746	Upe	8836
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Tlo	8480	Tus	8570	Ubt	8660	Uk	8750	Upi	8840
Tlu	8481	Tut	8571	Ubu	8661	Ula	8751	Upj	8841
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		Zev	9866	Zk	9902			Zyd	9976
Zao	9830	Zew	9867	Zl	9903	Zud	9940	Zye	9977
Zap	9831	Zex	9868	Zm	9904	Zue	9941	Zyf	9978
Zaq	9832	Zey	9869	Zn	9905	Zuf	9942	Zyg	9979
Zar	9833			Zoa	9906	Zug	9943		
Zas	9834	Zez	9870	Zob	9907	Zuh	9944	Zyh	9980
Zat	9835	Zf	9871	Zoc	9908	Zui	9945	Zyi	9981
Zau	9836	Zg	9872	Zod	9909	Zuj	9946	Zyj	9982
Zav	9837	Zh	9873			Zuk	9947	Zyk	9983
Zaw	9838	Zia	9874	Zoe	9910	Zul	9948	Zyl	9984
Zax	9839	Zib	9875	Zof	9911	Zum	9949	Zym	9985
		Zic	9876	Zog	9912			Zyn	9986
Zay	9840	Zid	9877	Zoh	9913	Zun	9950	Zyo	9987
Zaz	9841	Zie	9878	Zoi	9914	Zuo	9951	Zyp	9988
Zb	9842	Zif	9879	Zoj	9915	Zup	9952	Zyq	9989
Zc	9843			Zok	9916	Zuq	9953		
Zd	9844	Zig	9880	Zol	9917	Zur	9954	Zyr	9990
Zea	9845	Zih	9881	Zom	9918	Zus	9955	Zys	9991
Zeb	9846	Zii	9882	Zon	9919	Zut	9956	Zvt	9992
Zec	9847	Zij	9883			Zuu	9957	Zyu	9993
Zed	9848	Zik	9884	Zoo	9920	Zuv	9958	Zyv	9994
Zee	9849	Zil	9885	Zop	9921	Zuw	9959	Zyw	9995
		Zim	9886	Zoq	9922			Zyx	9996
Zef	9850	Zimmerman	9887	Zor	9923	Zux	9960	Zyy	9997
Zeg	9851	Zin	9888	Zos	9924	Zuy	9961	Zyz	9998
Zeh	9852	Zio	9889	Zot	9925	Zuz	9962	Zz	9999
Zei	9853			Zou	9926	Zv	9963		
Zej	9854	Zip	9890	Zov	9927	Zwa	9964		
Zek	9855	Ziq	9891	Zow	9928	Zwe	9965		
Zel	9856	Zir	9892	Zox	9929	Zwh	9966		

PART III

Applications in the University Business Office

PART III

Applications in the University Business Office

CHAPTER I

The State University of Iowa

By
W. H. Cobb, *Comptroller*
D. W. Bray, *Chief Accountant*

ACCOUNTING at the State University of Iowa is centralized and controlled in the University Business Office. The major portion of the routine accounting and analysis is done mechanically on the Hollerith Tabulating equipment. The following machines are used:

3 Alphabetic punches
1 Numerical punch
1 Reproducing Gang Punch
2 Verifiers
1 Horizontal card counting sorter with multiple column selection device
1 Horizontal sorter
1 Five Bank printer
1 Alphabetic accounting machine

The equipment is centralized in the tabulating and sorting section, one operator being able to keep two or more machines in use at the same time, although enough space has been allowed for two operators. The diagram Fig. 70 will give an idea of the physical layout, which includes filing equipment for a capacity of over one million cards.

The personnel of the Statistical Service Department includes the Adviser on Educational Procedure; a manager, a machine operator and two part time assistant operators; three punch operators and two part time assistants; and a clerical assistant. The Comptroller and Chief Accountant give supervision.

About 395,000 cards per year are used for accounting purposes. In addition to these about 150,000 per year are necessary for educational and special scholastic studies.

Voucher Register, Inter-Departmental Transfer Register, Statements of Account, and Analysis of Expenditures

The accounting card (Fig. 59) provides for printing the following information regarding vouchers.

1. The department.
2. Type of entry, that is, whether expense vouchers, inter-departmental transfer vouchers, journal vouchers. correction vouchers or cash receipt vouchers.
3. Voucher number.
4. Account number (See pp. 115 to 121).
5. Expense analysis (See pp. 121 to 125).
6. Class of Commodity.
7. Amount.
8. Payee.

From these cards the following records are listed:

1. The Voucher Register (See Fig. 71).
2. The Register of Inter-departmental debits and credits (See Figs. 72 and 73).
3. The Statement of Account (See Fig. 74).
4. Summary of Statement totals (See Fig. 75).
5. Analysis of Expenditures by accounts.
6. Analysis of Commodities purchased.

The Voucher Register is made in duplicate, the copy being attached to the envelope which contains the vouchers listed.

The statements of account are made in duplicate or triplicate, the copies being distributed to the Deans and Heads of the various University departments at the end of each month.

The complement figures appearing in the "Net Free Balance" field of the summary statement (Fig. 75) indicate an overdraft in the particular account.

Bank Reconciliation and Payee Register

Tabulating card (Fig. 60) is known as the duplicate warrant card and serves the two-fold purpose of reconciling the bank account and making an alphabetic register of payees. Duplicate warrant cards are purchased pre-numbered and pre-punched with the numbers which are to be assigned to the University vouchers. On these cards are made carbon copies of the warrants, showing the date, the name of the payee, the amount and explanation. After these cards are punched they are put into an "outstanding warrant" file where they remain until the paid warrants of like number are returned from the bank. The duplicate cards of the paid warrants are then promptly removed from the "outstanding" file and placed in the "paid" file. By this procedure, it is possible to make a bank reconciliation at any time, as the amount of outstanding warrants is readily available. After the end of each month all "paid" duplicate warrant cards are sorted alphabetically to list a firm register which is often referred to in connection with the payment of accounts. The checking of paid warrants against the voucher register, to ascertain the amount outstanding, and the hand filing of some five thousand duplicate warrant slips each month is thereby eliminated.

Each day the total of the duplicate warrant cards is proven with the total of the accounting cards (Fig. 59), thus giving a check on accuracy, in addition

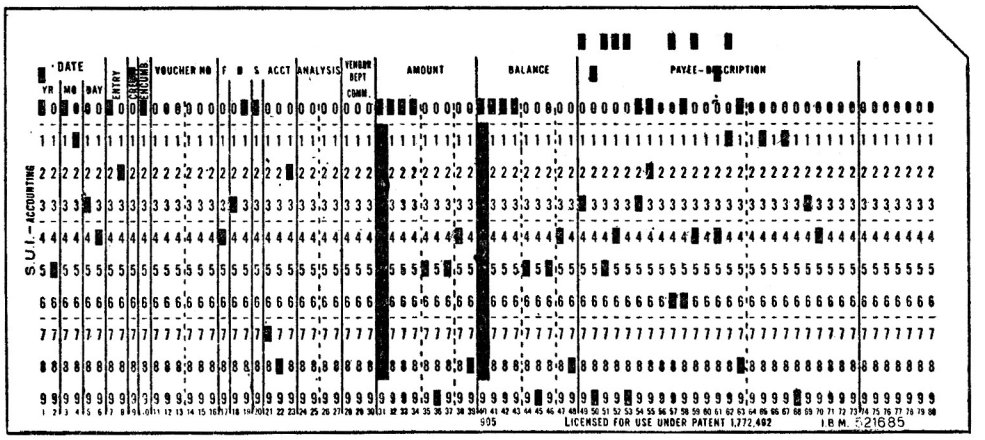


FIG. 59

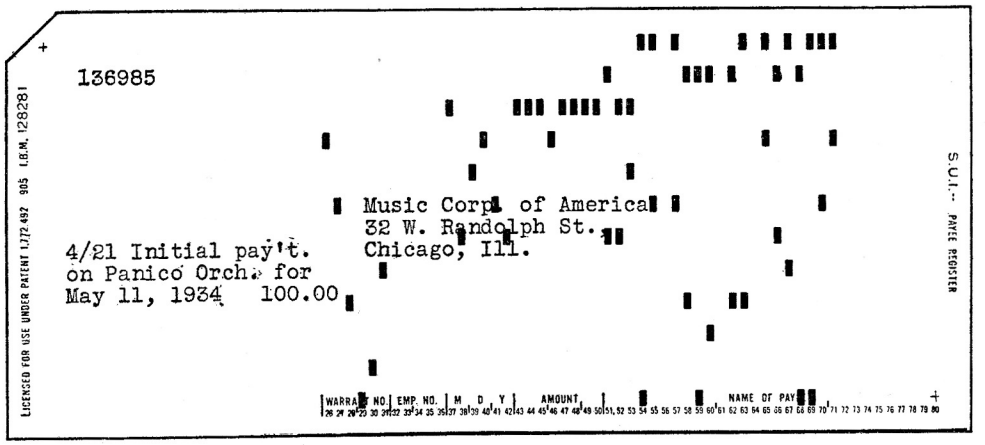


FIG. 60

to the usual routine of running all cards through a verifying punch. Periodically, the total of the duplicate warrant cards for salaries is used to prove the accuracy of the salary cards (See Fig. 61) from which the payrolls are made.

Salary Pay Rolls

Card form Fig. 61 is used in making the salary pay rolls for the full time personnel of the University. One card is filled out for each person. If an employee is working in more than one department a card is made for each position. When the payroll (Fig. 76) is run, these positions are automatically added together to give a total amount of payment for the month. It is possible through the use of these cards to prepare a report by rank or position to show the distribution of salaries paid throughout the University. A few simple rules have been set up to establish a salary accounting routine as follows:

1. a. Fill out a Master Card (see Fig. 61) for each employee.
   b. If salary is paid from more than one salary account or department, make

a separate card for each account or department.

2. a. When an employee resigns, remove his original master card to the transfer file.
   b. If salary is due for a portion of the month only, make a deduct card for the unused portion.
3. a. When an employee transfers from one department to another, remove his original master card to the transfer file and prepare a new one for the new department.
   b. If the change occurs within the month, both the original and new master cards are left in file until after the pay roll is run. To adjust each of these monthly amounts to the figure actually paid, temporary adjustment cards are inserted, deducting that proportion of the monthly salary which represents the unearned amount in each position.
4. When an amount is to be deducted from an employee's salary for a specified period (such as in the case of a leave of absence without pay) make a deduct card to bring monthly salary to correct amount.
5. a. When an employee's salary is to be increased or decreased, remove the original master card to the transfer file and make a new one for the new amount.
   b. If the change occurs within the month, rather than at the end of the month, follow instructions under 3b., above.

Routine for Analyzing Student Loan Fund Operations

Card form Fig. 62 is used to control the operation of the Student Loan funds and to list at the end of each month, the loans outstanding. A loan number is assigned at the time each loan is made and this, with the name of the student, is typed on the card. The card provides space for information as to the date the loan is made, the date it is due, the loan number, the number of the loan account on which it is made, the amount of the loan, the date of payment, the amount of interest collected, and the name of the student. For statistical purposes, the name of the college in which the student is registered, sex, race, home state, and the type of security are listed. A tabulating card is punched for each loan issued and for each payment on principal or interest. All of these cards are sorted together and tabulated to list, alphabetically, the resultant amounts outstanding, showing dates due. It will be noticed that these cards are flexible in providing for many different types of information regarding student loans.

Procedure in the Matter of Tuition and Fees

Card form Fig. 63 is used in tuition accounting. At the time of registration, the fee cards (Fig. 64), showing the cash register receipt number and the amount of payment, are taken from the Cashier's Office as soon as they have been certified by the cash register, and punched on this tabulating card form to show the date, the term or session, the type of fee (whether tuition, military deposit, physical education deposit, etc.) the college or department, the

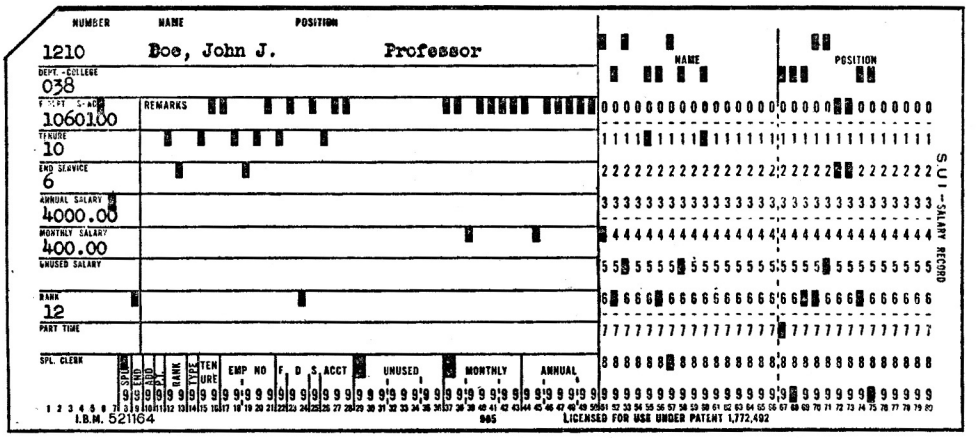


FIG. 61

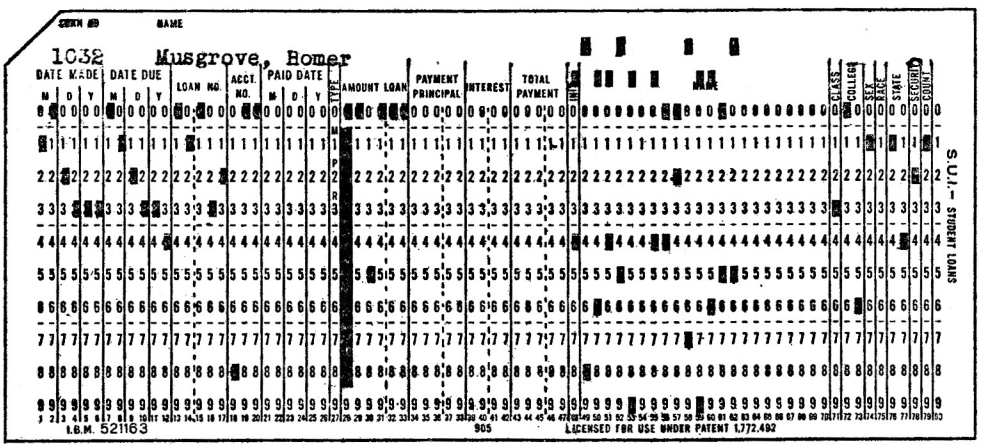


FIG. 62

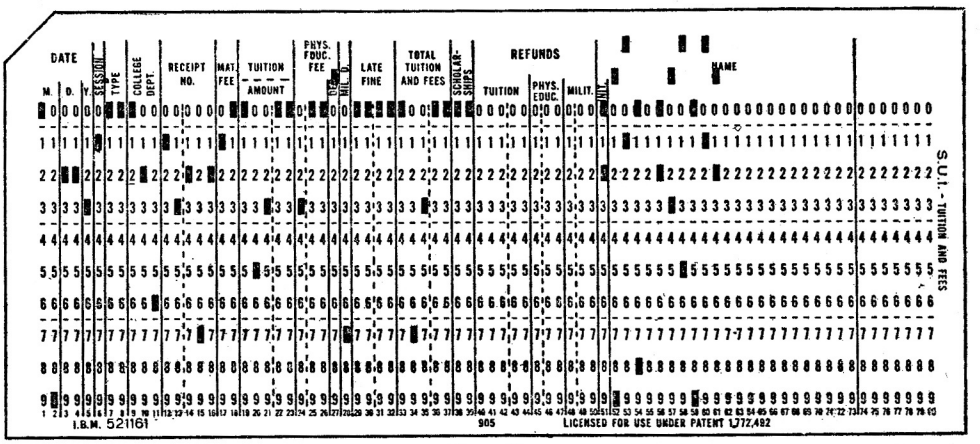


FIG. 63

cash register receipt number, the amounts of the various fees, and the name of the student. These cards are then sorted alphabetically at the end of the day,

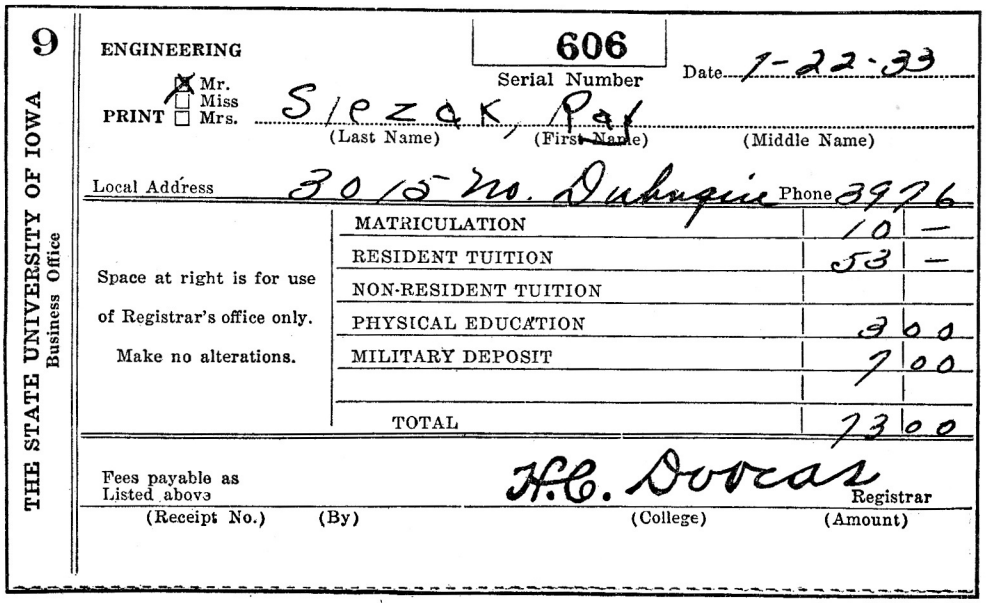

9
THE STATE UNIVERSITY OF IOWA
Business Office
ENGINEERING
606
Serial Number
Date 1-22-33
☒ Mr.
☐ Miss
PRINT ☐ Mrs.
Siczak Raf
(Last Name) (First Name) (Middle Name)
Local Address 315 No. Dubuque Phone 3976
Space at right is for use of Registrar's office only. Make no alterations.
MATRICULATION 10 —
RESIDENT TUITION 53 —
NON-RESIDENT TUITION
PHYSICAL EDUCATION 3 00
MILITARY DEPOSIT 7 00
TOTAL 73 00
Fees payable as Listed above
H.C. Dorcas
Registrar
(Receipt No.) (By) (College) (Amount)

FIG. 64

and from them a tabulation is made showing the name of each student, together with the cash register receipt number and the amount of payment (Fig. 77). The total of this tabulation is proven with the cash register total daily. Refunds of tuition or fees made at subsequent periods are punched on the same type of card. When these are sorted with the original cards punched at the time of registration, a complete tuition record with each student is obtained. Following the registration period, these cards are compared with the master cards in the Registrar's Office to assure the accounting department that there are no students attending classes who have failed to pay their fees. In addition to the alphabetic punching of the name on the tuition cards, the serial number of the student, which is assigned by the Registrar's Office, is punched to aid in sorting and verification.

General Stores Invoices

Card form Fig. 65 is designed to make invoices of materials issued to departments from the General Stores department. Numbered sales tickets are made in the Warehouse showing the date of issue, the department to which the materials are issued, the classification of expense, the building in which used, and the amount. This information is then transcribed to the tabulating card and posted by the alphabetic printer to the stores invoice. (See Fig. 78.) These cards are accumulated until the end of the month at which time the stores invoice is printed in triplicate. One copy serves as the source of information for charges to the various departments; one copy is sent to the department charged, and the

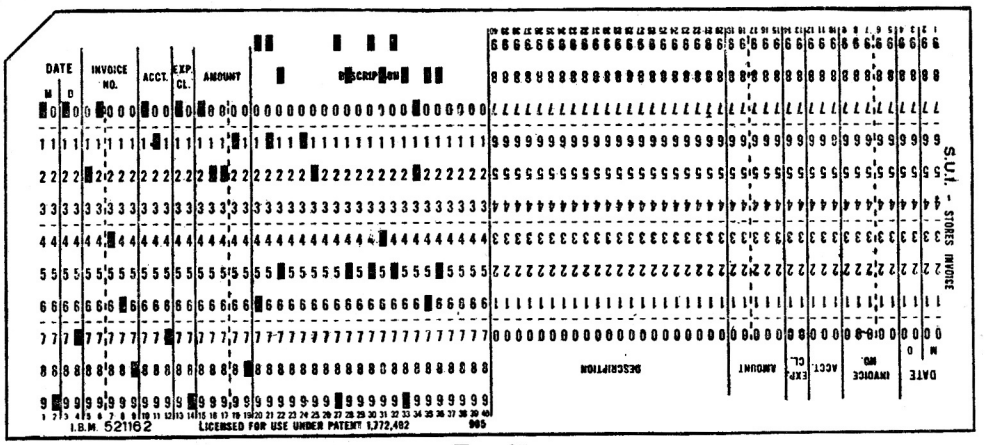


FIG. 65

last is retained in the Warehouse files. The card is made in tumble fashion, thereby making it possible to use each one twice at a substantial saving.

University Hospital Accounting

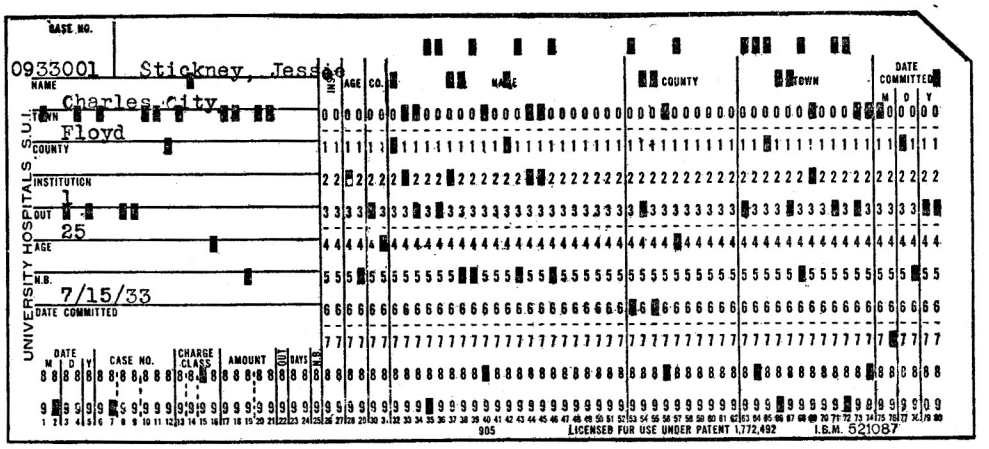


FIG. 66

Card form Fig. 66 tabulates the monthly state patient billing of patients treated at the University Hospital. At the time of admission each patient is assigned a case number. This with the name of the town, county, age of the patient, date of commitment are entered on the admission slips and punched on the master card. About 150,000 cards per year are punched to show the daily charges by date, case number, classification and amount. At the end of each month they are sorted to make the schedule of charges billed the state (see Fig. 79), and at the end of the year they are sorted to give the complete record of each patient during the entire year and used to make an alphabetical listing by counties. Daily reports made to the Hospital Administrator indicate the earnings of the Hospital from state patient figures. (See Fig. 80.) A second

report, Fig. 81, summarizes the transportation charges of state patients. The sources of all entries on Hospital state patient cards are the admission slips, charge slips, and the expense vouchers originating in the Hospital. After passing through the Statistical Service Department, these original records are filed permanently.

Hospital payrolls are made on Fig. 76 by use of card form Fig. 61. Adjustments from the basic salary amount, new appointments and resignations are reported to the Statistical Service Department on Form 82.

In addition to making the payroll, these cards (Fig. 61) list salary expenditures by positions and departments.

Permanent Property Inventory

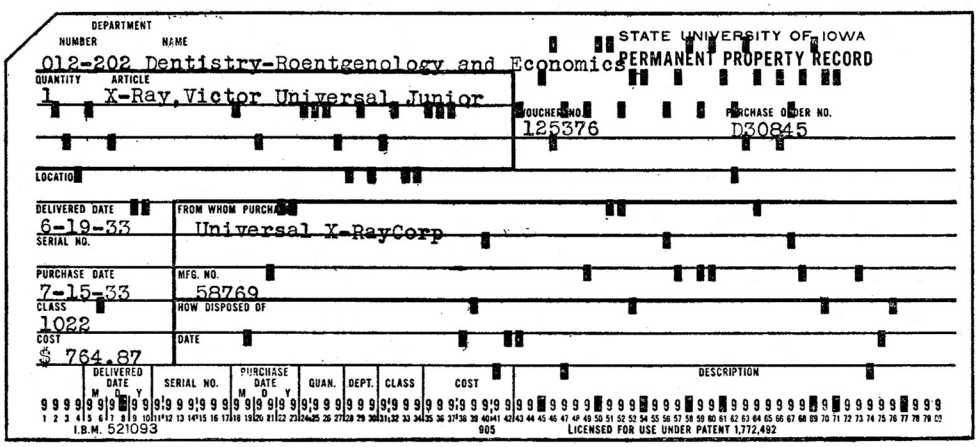


FIG. 67

Permanent Property Inventory card form, Fig. 67 is designed to keep a record of permanent equipment purchased. One card is written for each item of equipment, showing description, date purchased, cost, voucher number, purchase order number, etc. Each card is codified to show the classification (See pp. 125 to 126) and the department to which it is delivered, thus making it possible to list equipment by type and location. This is a great convenience in view of the fact that it is frequently desired to learn how many typewriters, microscopes, pieces of photographic equipment, etc., are owned, and their exact location on the campus. At the end of each year a complete tabulation of departmental equipment is made, one copy being sent to the department for verification, and the original bound to substantiate the figures for departmental totals shown in the annual report.

Dormitory Accounts Receivable Control

Charges and credits affecting individual student accounts in the dormitories are punched on tabulating cards, (Fig. 62 is used for this purpose because of the similarity in requirements with Student Loan control) and summarized at the end of each month to show the total charges and receipts on account,

and to list alphabetically the accounts outstanding. The card provides for showing the amount of the contract entered into by each student for each semester, the room number to which he is assigned and the name of the dormitory. Thus, at any time may be listed information showing room occupancy, the estimated income from board or room, the cash received, and the resulting accounts outstanding.

Physical Plant Pay Rolls and Job System

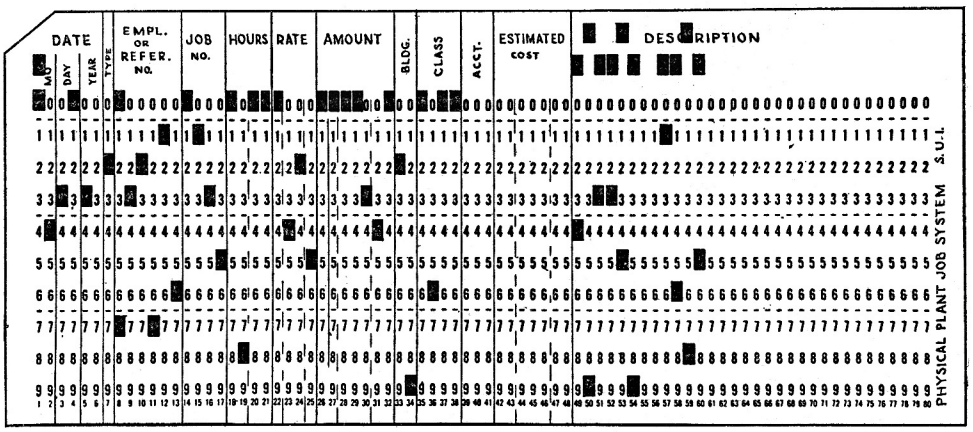


FIG. 68

The basis of the Physical Plant Pay Roll is the Time Slip (see Fig. 69) which is sent to the Statistical Service Department daily by the time keeper.

Empl. Name Adair, Lee E Empl. No. 0025

Job or B. & G. Dept. No. 055 Date 5-3 1934

No. of Hours 6 Rate 43 Amount $ 2.58

Description of work Repairing wall cases in room C 501

Bldg. 46 Class 01 Approved John J. Doe
Foreman

State University of Iowa
Dept. of Grounds & Buildings
10M:4-34:3414

TIME CARD

FIG. 69

There a tabulating card (Fig. 68) is punched for each slip. These cards, together with the purchase vouchers on which charges for materials are billed,

supply the information for the entire job cost accounting system and are used to make the following records:

Pay Roll Distribution ..... See Fig. 83
Pay Roll ..... See Fig. 84
Employee Time Record ..... See Fig. 85
Report of Jobs in Process ..... See Fig. 86
Jobs Closed ..... See Fig. 87
Job Vouchers (Detailed list of all charges on each job) ..... See Fig. 88

APPENDIX TO PART III

Applications in the University Business Office

CHAPTER I

The State University of Iowa

SECTION I—ILLUSTRATIONS OF REPORTS, ETC. SECTION II—CODES

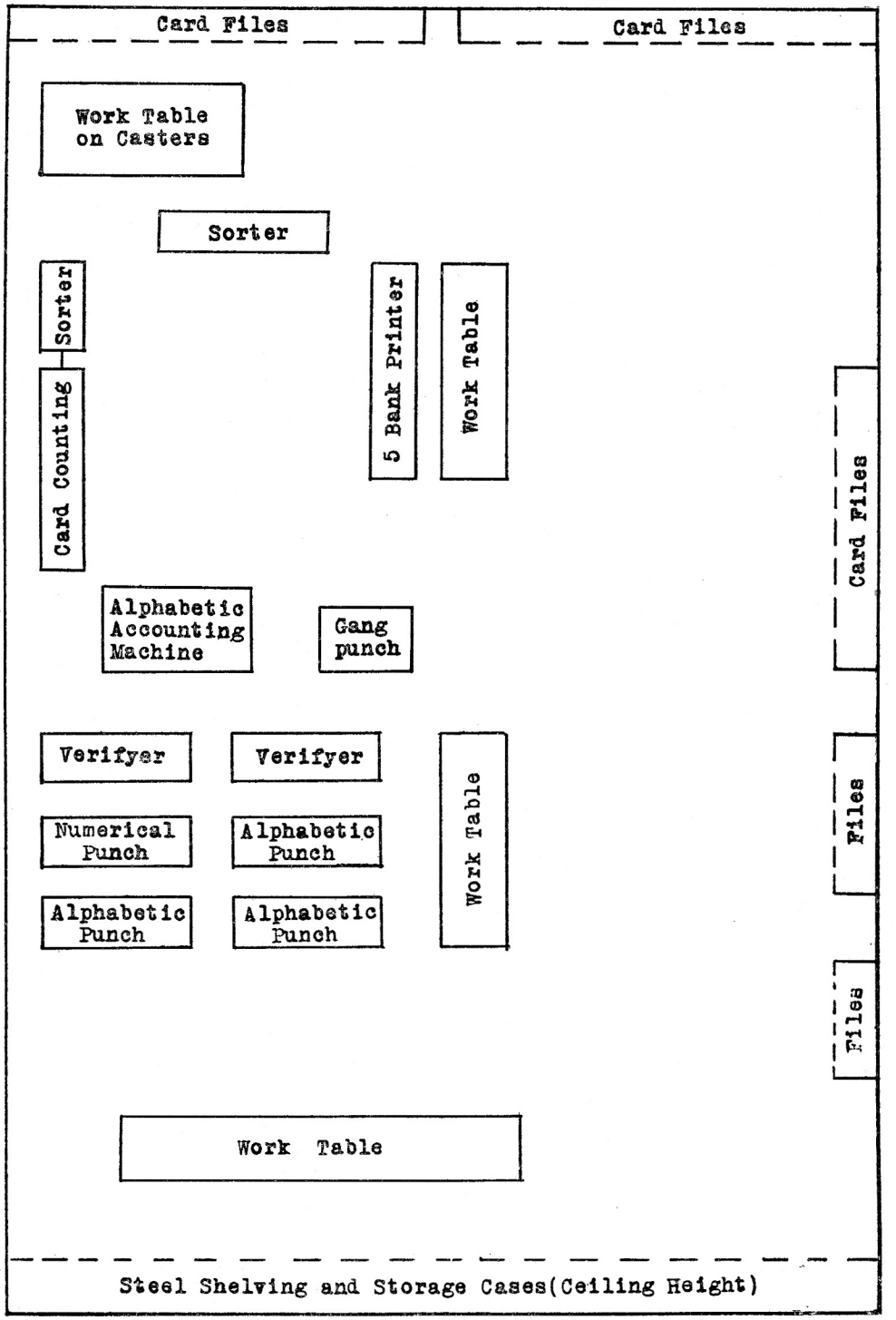

Card Files
Card Files
Work Table on Casters
Sorter
Sorter
Card Counting
5 Bank Printer
Work Table
Card Files
Alphabetic Accounting Machine
Gang punch
Verifyer
Verifyer
Work Table
Numerical Punch
Alphabetic Punch
Files
Alphabetic Punch
Alphabetic Punch
Files
Work Table
Steel Shelving and Storage Cases(Ceiling Height)

Fig. 70

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

PAGE NO. _____

VOUCHER REGISTER

MONTH OF MAY 1934

DAY	VOUCHER NUMBER	PAYEE	FUND	ACCOUNT	NUMBER OF ITEMS	AMOUNT
11	151236	CANDY AND CO INC	3	380	1	20 91
11	151237	ELECTRIC MOTOR SERVICE	3	380	1	49 50
11	151238	FISHER SCIENTIFIC CO	3	380	1	6 32
11	151239	GLASCO PRODUCTS CO	3	380	1	5 82
11	151240	HILD LEATHER CO	3	380	1	100 00
11	151241	JOESTING AND SCHILLING	3	380	1	35 64
11	151242	JENSEN DUNN CO	3	380	1	7 70
11	151243	KRESGE S S CO	3	380	1	9 60
11	151244	KARLS PAINT STORE	3	380	1	4 05
11	151245	KILLIAN CO	3	380	1	89 400
11	151246	LEWIS MFG CO	3	380	1	32 32 84
11	151247	LIEBEL FLARSHEIM CO	3	380	1	8 93
11	151248	LINDER TIRE SERVICE	3	380	1	6 71 5
11	151249	SANDBERG W J CO	3	380	1	20 29
11	151250	THOMAS HAROLD C	3	380	1	50
11	151251	YOUNG W A	3	380	1	44 23 1
11	151252	WILKINSON LOTIS	3	380	1	1 67
11	151253	ZEISS CARL INC	3	380	1	6 27
11	151254	STANDARD CHEM CO	3	380	1	300 00
11	151255	PILLING GEO P AND SO	3	380	1	27 93
11	151256	PARIS CLEANERS	3	380	1	3 00
11	151257	ROSS WILL INC	3	380	1	30 00
11	151258	PITTS PLATE GLASS CO	3	380	1	24 01
11	151259	MUELLER V AND CO	3	380	2	99 59
11	151260	GEVAERT CO OF AMER	3	380	1	200 09
11	151261	GAYNOR BAGSTAD CO	3	380	1	7 11
11	151262	WELCH COOK BEALS CO	3	381	1	30 52
11	151263	YELLOW CHECKER CAB	3	381	1	45 61
11	151264	RADIOLOGICAL SOC OF N	4	506	1	34 38
11	151265	GENL BIOLOGICAL SUPPLY	4	522	1	3 38
11	151266	SVIHLA MRS RUTH	4	522	1	14 98
11	151267	PETERSON ALBERT E	4	522	1	25 00
11	151268	COUNCIL OF CHURCH BD O	4	535	1	1 50
11	151269	METHODIST BK CONCERN	4	535	1	35
11	151270	ROYAL TYPE CO INC	4	545	1	31 00
11	151271	INTERSTATE POWER CO	4	554	1	60 00
11	151272	IOWA ELECTRIC CO	4	554	1	20 00
11	151273	DAILY IOWAN	4	693	1	28 73
11	151274	WHETSTONES	4	703	1	1 02
11	151275	YETTERS	4	750	1	66
11	151276	UNIV BOOK STORE	4	750	1	68
11	151277	COLONIAL BAKING CO	4	776	1	21 80
11	151278	PLASS E D	1	151	1	15 10
11	151279	FITZGERALD R H	1	125	1	11 90
11	151280	INTERNATL BUS MACH CO	3	365	1	6 95
11	151281	REVOLVING ADV FD	3	380	4	649 10
11	151282	WARNER IRENE K	1	033	1	1 87
11	151283	HAYWARD THOMPSON CHE	1	061	2	653 07
11	151284	BOYLSTON STEAM SPEC CO	1	062	2	13 24
11	151285	FARLEY A T	1	075	1	12 90
11	151286	BROWN FLORENCE	1	126	1	14 25
11	151287	LOCKWOOD L	1	126	1	9 00
11	151288	PEEK L H	1	161	1	10 62
11	151289	ALLEN G EARL	1	163	1	13 50
11	151290	UKENA MAYNARD	1	201	1	10 20
					TOTAL $	4437 14*

FIG. 71

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

PAGE NO. _____

INTER-DEPARTMENTAL JOURNAL

MONTH OF MAY 1934

DAY	NUMBER	ACCOUNT CREDITED	FUND	ACCOUNT CHARGED	NO. OF ITEMS	AMOUNT
14	ST 574	INTER CHURCH COUNCIL	4	766	1	3 00
14	ST 575	WHETSTONE DIN SERV	4	772	1	2 26
14	ST 576	WOMENS ATHL ASSOC	4	765	1	32 11
14	ST 577	HIGH SCHOOL CAFE	4	749	1	23 45
14	ST 578	OPHTHALMOLOGY FEES	4	505	1	2714 31
14	ST 579	SCH REL ROCKEFELLER	4	716	1	208 11
14	ST 580	STUDENT ORG ADMIN	4	649	1	26
14	ST 581	PERSHING RIFLES	4	762	1	60 00
14	ST 582	I M U HSE OPER	4	762	1	62 50
14	ST 583	I M U DIN SERV	4	492	1	74 72
14	ST 584	PHYSIOLOGY DEPT	1	163	1	55 76
14	ST 585	LABOR PAYROLL DIST	1	052	38	3348 67
14	ST 586	TEST	1	115	2	14 86
14	ST 587	I M U DINING SERV	4	622	3	28 81
14	ST 588	MORTAR BOARD	4	711	1	1 50
14	ST 589	UNIV HOSPITAL	1	031	15	107 93
14	ST 590	PHYSICAL PLANT STOCK	3	362	1	471 73
14	ST 591	WHETSTONE DINING SERV	4	776	1	18 27
14	ST 592	STUDENT ORG ADMIN	4	628	39	130 62
14	ST 593	WATER COSTS	3	362	1	2 80
14	ST 594	PHYSICAL PLANT STOCK	3	362	1	347 24
14	ST 595	UNIV THEATRE	4	550	1	150 00
14	ST 596	WOMENS ASSOC	4	758	1	60
14	ST 597	IOWA PUBLISHER	1	012	1	55 00
14	ST 598	ACADEMIC MEET	1	234	1	35 25
14	ST 599	PHYSICAL PLANT STOCK	3	362	1	4 57
	ST	SUSPENSE ACCT	1		1	

FIG. 72

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

PAGE NO. _____

ANALYSIS OF INTER-DEPARTMENTAL TRANSFER CREDITS

MONTH OF MAY 1934

FUND	ACCOUNT NUMBER	ACCOUNTS CREDITED	AMOUNT	FUND TOTALS
1	060	Electric Cost at Switchboard	2 80	
1	160	Otolaryngology	55 76	
				58 56 *
2	350	General Stores	823 54	
				823 54 *
3	370	Payroll Distribution	3348 67	
3	370	Payroll Distribution	9 10	
3	380	General and Children's Hospitals	107 93	
3	400	Howard House	62 50	
3	410	Quadrangle Cafeteria	417 49	
3	410	Quadrangle Cafeteria	23 45	
3	440	Correspondence Study	19 76	
3	440	Correspondence Study	35 25	
				4024 15 *
4	500	Gynecology and Obstetrics Fees	2714 31	
4	530	Fleischmann Yeast Co.	208 11	
4	660	Iota Sigma Pi	55 00	
4	660	Iota Sigma Pi	3 00	
4	670	International Student Council	1 50	
4	690	Orchesis	60 00	
4	750	Union Board	150 00	
4	750	Union Board	32 71	
4	770	Campus Social Workers Club	20 53	
4	780	Student Organizations Administration	130 88	
				3376 04 *

FIG. 73

TRUST FUND 4300595
ALUMNI ASSOCIATION

STATEMENT OF ACCOUNT
STATE UNIVERSITY OF IOWA BUSINESS OFFICE

(ORIGINAL)

DATE MO.	DAY	YEAR	VOUCHER NUMBER	DESCRIPTION	EXPENSE CLASS	(1) EXPENDITURES	(2) ALLOCATIONS AND CREDITS	(3) NET FREE BALANCE
3	1	34		CREDITS FWD MARCH 1 1934			81786	
3	1	34		DEBITS FWD MARCH 1 1934		72831		
3	8	34	142455	ANDERSON MRS EDWARD	0600	1980		
310		34	CRV286	CASH RECEIPTS			7500	
312		34	CRV287	CASH RECEIPTS			14000	
313		34	143278	HART CLYDE W	0300	1855		
313		34	143279	MARTIN HERBERT	0300	699		
313		34	143280	STEWART G W	0300	2675		
313		34	143281	PHILLIPS C A	0300	1940		
313		34	CRV289	CASH RECEIPTS			7500	
314		34	CRV290	CASH RECEIPTS			8700	
315		34	CRV291	CASH RECEIPTS			6516	
316		34	143485	WILLIAMS R F	0300	600		
316		34	143486	GILMORE E A	0300	620		
317		34	143663	LAUER EDWARD H	0300	5279		
319		34	CRV295	CASH RECEIPTS			4300	
320		34	144746	PACKER P C	0300	4122		
320		34	CRV296	CASH RECEIPTS			600	
321		34	CRV297	CASH RECEIPTS			1000	
322		34	CRV299	CASH RECEIPTS			1200	
323		34	145358	BRESNAHAN GEORGE T	0300	1165		
323		34	CV 391	134400 BURKETT UPDEGRAFF	0400	999998800		
326		34	145495	SOLEM O M	0300	750		
326		34	CRV302	CASH RECEIPTS			1620	
327		34	145597	FITZGERALD R H	0300	2310		
327		34	CRV304	CASH RECEIPTS			1100	
328		34	145665	ENSIGN F C	0300	875		
328		34	CRV305	CASH RECEIPTS			1400	
328		34	ST 474	MULTIGRAPH	0200	1120		
329		34	CRV307	CASH RECEIPTS			500	
330		34	CRV309	CASH RECEIPTS			1200	
						97621	138922	41301*

TOTALS OF ALL COLUMNS INDICATED BY ASTERISK * IN RIGHT HAND MARGIN. ANY CREDITS IN COLUMN 1, DEDUCTIONS IN COLUMN 2 OR OVERDRAFTS IN COLUMN 3 WILL APPEAR IN COMPLEMENT—FOR EXAMPLE, DEDUCTION OF 37.51 IS SHOWN 999962249

FIG. 74

STATEMENT OF ACCOUNTS

As of _____

Account No.	Name of Account	Credits	Expenditures	Encumbrances	Net Free Balance
	STUDENT ORGANIZATIONS				
4300 610	A F I	17483	14294		3189
4300 611	ALPHA PHI OMEGA	1112	20		1092
4300 612	ALL UNIV MENS DINNER	9189	9189		
4300 613	ALL UNIV WOMENS DINNER	49			49
4300 614	ASSOC STUDENTS OF ENGR	50684	25613		25071
4300 615	ASSN STUD OF JOURNALISM	18349	5125		13224
4300 617	BAND FUND	187			187
4300 618	BARRISTERS BALL	23671	23671		
4300 619	BETA GAMMA SIGMA	5767	5646		121
4300 620	CLASSICAL CLUB	1574	3394		999998180
4300 621	CLASS 1934 COLLEGE OF MED	1745			1745
4300 622	COMMERCE CLUB	21094	9230		11864
4300 623	COMMERCE MART	56050	56050		
4300 624	CONTINUO CLUB	9039			9039
4300 625	COSMOPOLITAN CLUB	768			768
4300 626	CURRIER HALL ASSOC	77503	32722		44781
4300 628	DELTA SIGMA RHO	781			781
4300 629	DOLPHIN CLUB	56665	56122		543
4300 630	EASTLAWN ASSOC	18227	13525		4702
4300 632	ETA SIGMA PHI	6058	2263		3795
4300 637	FRESHMAN PARTY CLASS 1937	60900	39284		21615
4300 638	SOPH COTILLION CLASS 1936	69877	66649		3228
4300 639	GENERAL FORENSICS	1000	1000		
4300 643	GERMAN CLUB	3279	2676		603
4300 644	GLIDER CLUB	5130			5130
4300 645	GRADUATE CLUB	13845	13460		385
4300 649	HAMLIN GARLAND LIT SOC	964			964
4300 650	H S FORENSIC LEAGUE	25230	21609		3621
4300 651	HOMECOMING PARTY	90000	90000		
4300 652	HOME ECONOMICS CLUB	30098	15924		14174
4300 654	HAWK NIGHT		17500		999982500
4300 655	I CLUB				
4300 656	I BLANKET HOP	66249	66249		
4300 657	INTER COLLEGIATE DEBATE	14186	8922		5264
4300 658	INTERFRATERNITY COUNCIL	15338	4860		10478
4300 659	INTER PROF SORORITY	1237			1237
4300 660	IOTA SIGMA PI	3168			3168
4300 661	IOWA DAMES CLUB	20629	8853		11776
4300 662	IOWA PUBLISHER	97728	90037		7691
4300 663	IOWA LAW STUDENTS ASSOC	61053	31492		29561
4300 665	IOWA TRANSIT	29050	29050		
4300 666	INTER CHURCH COUNCIL	200			200
4300 668	IA JUNIOR COLL FORENSIC	3287	999998419		4868
4300 669	SENIOR HOP CLASS 1934	97770	91975		5795

FIG. 75

PAYROLL

MAY 1934

DEPARTMENT STATE UNIVERSITY OF IOWA

EXP. CL.	DEPT.	WARRANT NO.	EMPL. NO.	NAME	AMOUNT
			0194	ANDERSON H R	13557
			0214	ANDREWS RUTH	3400
			0444	BARNES HELEN	9775
			0810	BLACKSTONE E G	16850
			0834	BLISS AMY L	8500
			1035	BRAND EDWARD	1062
			1436	CARPENTER M F	21166
			1571	CHRISTENSEN E H	8500
			1967	CRESAP MARY E	3825
			2258	DENTER MILDRED	5950
			2330	DICKSON VELMA	475
			2645	EDDY HELEN	18216
			3808	GUNN AGNELLA	15300
			3855	HAGG HAROLD	4750
			3976	HANSON KATHLEEN	5500
			4623	HUNGERFORD R	5950
			4922	KAMBLY PAUL	8500
			5113	KISTLER JOY	8000
			5366	LANE RUTH	7650
			6274	MCQUADE RUTH T	5464
			6796	NEIDER LEONE	5500
			6832	NEWBURN H K	23720
			7179	PATZIG EDNA	5936
			7324	PIERCE ANNE	9321
			7352	PLAEHN IRMA B	5950
			7533	RAIFORD ALICE	10200

FIG. 76

STATE UNIVERSITY OF IOWA
Business Office

Tuition and Fees Collected

NAME	RECEIPT NUMBER	AMOUNT	NAME	RECEIPT NUMBER	AMOUNT
DOROTHEA B BIGNELL	30768	30 00			
ERNEST CASSILL	30765	30 00			
LEO J. DVORAK	30788	10 00			
LEO J. DVORAK	30789	15 00			
LESTER GARWOOD	30795	18 00			
HAROLD D HARRINGTON	30801	15 00			
GUY R. HALL	30806	10 00			
EUGENE L. HILL	30808	15 00			
			TOTAL		

CORRECT VVRC AUDITOR — BALANCED WITH CASH: CR CASHIER, EvBH BOOKKEEPER — MACHINE 1 — DATE FEB 3 1934 — C.R.V. NO. 134

1M:3-32:8864 — PAGE NO.

FIG. 77

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

STORES INVOICE

MULTIGRAPH

ACCOUNTING DEPARTMENT

ACCOUNT NO.	MONTH	DAY	INVOICE NO.	ITEM - DESCRIPTION	EXP. CLASS	AMOUNT
364	03	07	44736	SUPPLIES	01	108
364	03	17	45254	DESMOINES IA	01	19
364	03	20	45340	RIBBON	04	125
364	03	22	45487	SUPPLIES	01	16
364	03	24	45551	MIMEO INK	04	1010
364	03	24	45552	MIMEO INK	04	1010
364	03	24	45636	HAULING	01	1840
						4128*

N. B. THIS IS YOUR FILE COPY LISTING STORES CHARGES MADE TO THE ABOVE NAMED ACCOUNT DURING THE MONTH INDICATED. PLEASE VERIFY AT ONCE. CALL EXTENSION 391 IF YOU HAVE ANY QUESTIONS OR CORRECTIONS. GENERAL STORES DEPT.

714-8 REDIFORM (TRADE MARK) INTERLEAVED, PATENTED, OTHER PATS. PEND., MFD. BY COSBY-WIRTH MAN. DOOE CO., MINNEAPOLIS, MINN.

FIG. 78

STATE UNIVERSITY OF IOWA
UNIVERSITY HOSPITALS

SCHEDULE OF CHARGES FOR STATE PATIENTS

MONTH OF May, 1934

NAME	TOWN	COUNTY	BOARD AND ROOM	SPECIAL FEES	TRANSPORTATION	DOCTORS EXAMINATION FEES	TOTAL
Jensen, A. A.	Des Moines	Polk	12 00	5 00	4 60	3 00	24 60
Abbott, C. E.	Cedar Rapids	Linn	93 00	19 00	12 50		124 50
Greenway, Wm. S.	Davenport	Scott	78 00	8 60	7 50	3 00	97 10
Parsons, Fred	Iowa City	Johnson	36 00	12 40	9 60	3 00	61 00
McElroy, R.A.	Des Moines	Polk	48 00	6 90	15 00		69 90
Eichhorn, M. A.	Atlantic	Cass	15 00	7 80	5 70	3 00	31 50

FIG. 79

State University of Iowa
Business Office

REPORT OF STATISTICAL SERVICE DEPARTMENT
HOSPITAL SPECIAL CHARGES TO STATE PATIENTS

Date MAY 1934

In (1) Out (0)	Classification of Expense Code No.	Description	Code No.	Amount	Amount
1	05	X-Ray	05	15750	
1	06	Operating Room	06	7600	
1	07	Glasses	07		
1	08	Radium	08	800	
1	10	Culture	10		
1	11	Tissue	11		
1	12	Diarsonal	12	150	
1	13	Ambulance	13		
1	14	Telephone	14	1240	
1	15	Telegraph	15		
1	16	Drugs	16	281	
1	18	Barber	18	525	
1	19	Braces	19		
1	20	Casts	20	3125	
1	22	Stores	22		
1	23	Miscellaneous	23		
1	24	Appliances	24		
1	31	Resectoscope	31		
1	34	Allergy Tests	34		
		TOTAL			29471*
0	05	X-Ray	05	3700	
0	06	Operating Room	06		
0	07	Glasses	07		
0	08	Radium	08		
0	10	Culture	10		
0	11	Tissue	11		
0	12	Diarsonal	12		
0	13	Ambulance	13		
0	14	Telephone	14		
0	15	Telegraph	15		
0	16	Drugs	16	1230	
0	18	Barber	18		
0	19	Braces	19		
0	20	Casts	20		
0	22	Stores	22		
0	23	Miscellaneous	23		
0	24	Appliances	24		
0	27	Meals	27	13400	
0	34	Allergy Tests	34		
		TOTAL			18330*
		GRAND TOTAL			47801*

BOARD AND ROOM
Patients Discharged 34 Days 288

FIG. 80

State University of Iowa
Business Office

REPORT OF STATISTICAL SERVICE DEPARTMENT ON
HOSPITAL TRANSPORTATION CHARGES TO STATE PATIENTS

Date MAY 9 1934 Voucher Number A 260

In (1) Out (0)	Classification of Expense Code No.	Description	Code No.	Amount	Amount
1	80	Railroad fare	80	7655	
1	81	Bus, Taxi, Ambulance	81	20	
1	82	Hotel, Meals, Telephone	82	4291	
1	83	Escorts' Wages	83	700	
1	85	Hospital Cars	85		
		TOTAL			12666*
0	80	Railroad fare	80	1440	
0	81	Bus, Taxi, Ambulance	81	480	
0	82	Hotel, Meals, Telephone	82	1301	
0	83	Escorts' Wages	83		
0	85	Hospital Cars	85		
		TOTAL			3221*
		TOTAL TRANSPORTATION			15887*
		Blood Transfusions	26		
		TOTAL			
1	90	Doctors' Examinations	90	18900	
0	90	Doctors' Examinations	90	5100	
		Doctors' Examinations	90		
		TOTAL			24000*
		GRAND TOTAL			39887*

* Represents patients who have not yet been given a hospital number, and who consequently have neither "in patient" nor "out patient" status.

FIG. 81

STATE UNIVERSITY OF IOWA
UNIVERSITY HOSPITALS

Report of Pay Roll Changes

☒ New Permanent Appointments

☐ Resignations

☐ Temporary Adjustments

MONTH OF May 1934

Type	Empl. No.	Amount Add	Amount Deduct	Name	Dept.	Position	Exp. Class	Explanation
1	1 3246	100.00		Henderson, H. J.	2248	30295	0700	New Employee
4	1 4470	250.00		Jackson, Beryl	1039	00201	0700	Transferred from 00239
4	1 4470		250.00	" "	1042	00239	1070	" to 00201

FIG. 82

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

PAY ROLL DISTRIBUTION
GROUNDS AND BUILDINGS DEPARTMENT

For Week Ending MAY 1934

2M:5-34:3766

For Month of .....

Name of Account	Account Number	Expense Class	Amount
Electric Cost at Switchboard	060	0639	816
Water Cost at Pump Header	061	0656	408
Dist. Cost Heat, Elec., and Water	062	0639	148
	062	0673	1480
	062	0674	4006
	062	0675	860
	062	0676	426
	062	0683	86
	062	0685	1068
	062	0686	891
	062	0693	740
Underground System	063	0601	602
	063	0603	594
Chemistry	103	0600	663
Military	109	0600	419
Physical Education Women	112	0600	340
Psychology	115	0600	408
Speech	116	0600	170
Graphic and Plastic Arts	126	0600	255
Pharmacy Supplies	211	0600	56
Law General Expense	221	0600	611
Education General Expense	231	0600	51
High School	234	0600	546
Library Supplies	281	0600	852
Summer Session Supplies	301	0600	204
Radio Broadcasting	312	0600	2765
Child Welfare General Expense	321	0600	464
Drug Stores Overhead	355	0600	476
Laundry Service	363	0600	1426

FIG. 83

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

PAY ROLL
GROUNDS AND BUILDINGS DEPARTMENT

For Week Ending MAY 1934
For Month Ending .....

Signature of Payee Acknowledges Receipt of Amount Shown

	Employee No.	Name	Hours Whole	Hours Fract.	Rate $	Rate c	Amount $	Amount c	Received Payment
1	0011	ABBOTT MRS GEORGE	28	50		56	15	96	1
2	0025	ADAIR LEE E	35	00		43	15	05	2
3	0032	ADRIAN CLARENCE G	22	00		51	11	22	3
4	0090	ANDERLIK JAMES	32	00		74	23	68	4
5	0146	ASH HERBERT E	20	00		68	13	60	5
6	0161	AUSTIN HARRY	19	00		68	12	92	6
7	0175	BACON WILLIAM F	24	00		43	10	32	7
8	0312	BENJAMIN CLAIR D	24	00		51	12	24	8
9	0442	BOEHM JOSEPH M		90		43		38	7 9
10	0543	BRIGHT CHARLES C	33	00		51	16	83	10
11	0545	BRIGHT ELLSWORTH L	36	00		64	23	04	11
12	0546	BRIGHT ERNEST L	32	00		51	16	32	12
13	0569	BROWN HAROLD M	12	00		43	5	16	13
14	0573	BROWN ROBERT R	7	00		43	3	01	14
15	0692	CAMPBELL DANNIE R	2	00		43		86	15
16	0702	CAPPS GILBERT	10	00		43	4	30	16
17	0707	CARLSON CHARLES W	17	00		68	11	56	17
18	0709	CARLSON ELMER	8	00		56	4	48	18
19	0722	CARSON EMBERT	32	00		74	23	68	19
20	0725	CARSON HUGH F	35	00		47	16	45	20

3M-5-34-3767

FIG. 84

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

EMPLOYEE TIME RECORD
GROUNDS AND BUILDINGS DEPARTMENT
For Month of MAY 1934

6M-5-34-3768

Employee Number	Name	Date Worked	Job Number	Class of Work	Bldg.	Hours Worked	Rate per Hour	Amount Earned
0709	CARLSON ELMER	5/3/34	2951			8 00	1 20	9 60
0709	CARLSON ELMER	5/4/34	2951			8 00	1 20	9 60
0709	CARLSON ELMER	5/5/34	2951			4 00	1 20	4 80
0709	CARLSON ELMER	5/7/34	2951			8 00	1 20	9 60
0709	CARLSON ELMER	5/8/34	2951			2 00	1 20	2 40
						30 00		36 00
0750	CERNY GEORGE J	5/3/34	2952			1 00	1 20	1 20
0750	CERNY GEORGE J	5/7/34	2951			2 00	1 20	2 40
						3 00		3 60
2006	HARPER FLETCHER R	5/3/34	2951			3 00	1 20	3 60
						3 00		3 60
2267	HOUCK GORDON H	5/3/34	2952			8 00	60	4 80
2267	HOUCK GORDON H	5/4/34	2952			8 00	60	4 80
2267	HOUCK GORDON H	5/5/34	2952			4 00	60	2 40
2267	HOUCK GORDON H	5/8/34	2952			4 00	60	2 40
						24 00		14 40
2427	JONES LEONARD G	5/3/34	2951			1 00	60	60
2427	JONES LEONARD G	5/4/34	2951			1 00	60	60
2427	JONES LEONARD G	5/7/34	2951			1 00	60	60
						3 00		1 80
3271	MOORE BERTON	5/4/34	2951			3 00	1 20	3 60
						3 00		3 60
3572	PARKER THOMAS J	5/3/34	2952			8 00	1 20	9 60
3572	PARKER THOMAS J	5/4/34	2952			8 00	1 20	9 60
3572	PARKER THOMAS J	5/5/34	2952			4 00	1 20	4 80
3572	PARKER THOMAS J	5/7/34	2952			8 00	1 20	9 60
3572	PARKER THOMAS J	5/8/34	2952			2 00	1 20	2 40
						30 00		36 00

FIG. 85

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

JOBS IN PROCESS
GROUNDS AND BUILDINGS DEPARTMENT

All open jobs are included in this report — Date MAY 1934

Account Number	Job Number	Description of Job	Date Authorized	Estimated Cost	Labor	Materials	Total	Orders Unpaid	Total
	2511	P W A OVERHEAD		100000	513 10	89 24	602 34		
	2668	WATER LINE TO LAW DORM	12 12 33	270000	436 26	2924 54	3360 80		
					949 36	3013 78	3963 14	*	
52	2256	CHLORINE FOR CHLORINEATOR	7 5 33			320 77	320 77		
52	29283	MOVING MULTIGRAPH MACHINERY	4 6 34	75000	61 30	27 48	88 78		
52	29284	MOVING MULTIGRAPH DEPT	4 6 34	100000	327 72	121 77	449 49		
					389 02	4700 2	8590 4	*	
55	1980	ANATOMY BLDG ROOF	3 1 33	3000000	795	3813 7	3893 2		
55	2107	INSULATION RETURN LINE	5 18 33	150000	51574	13499 4	18656 8		
55	2109	WEATHER STRIPPING	5 18 33	75000	11137	6166 25	6177 62		
55	2110	DENTAL BLDG HEATING	5 18 33	700000	111394	35704 5	46843 9		
55	29281	MOVE POWER LINE MULT DEPT	4 6 34	150000	14200	1790 4	3210 4		
55	2929	REPAIR PSYCHO HOSP FLUE		2500	2000		2000		
55	2930	SCREENS IN KELLOGG BLDG		6000	5478	3782	9260		
55	2967	EAST HALL REMODELING		120000	3237	420	3657		
55	2968	12 METAL ANGLE CORNERS		1500	408		408		
55	2995	BASEMENT REMODELING	4 25 34	300000	11409		11409		
					201632	116890 7	137053 9	*	
56	25982	GRADING WEST SIDE LEVEE	12 3 34	450000	370	36213 8	36250 8		
56	2796	RIP RAP LEVEE	12 3 34	550000	40300	2780	43080		
					40670	36491 8	40556 8	*	
71	2833	PHOTO MURAL		11400	5052	8090	13142		
					5052	8090	13142	*	
78	2944	AIR COAL CLEANER	4 6 34	50000	12157	6921	19078		
					12157	6921	19078	*	
103	2989	1 POLARISCOPE		1500	1292		1292		
					1292		1292	*	
104	2735	MOTOR AND BLOWERS		10000	8320	4548	12868		
104	2954	SHELF BRACKETS		1000	340	138	478		
					8660	4686	13346	*	
109	2994	GOVERNORS DAY MAY 12		2500	1440		1440		
					1440		1440	*	
111	2804	TRAPEZE APPARATUS		4100	5162	7417	12579		
					5162	7417	12579	*	
118	2891	4 DESK LAMPS		2500	1460	130	1590		
					1460	130	1590	*	

1M 5-34 3769

FIG. 86

STATE UNIVERSITY OF IOWA
Business Office

Jobs Closed
Grounds and Buildings Department
Month of MAY 1934

	Acct. No.	Job No.	Labor	Material	Overhead	Total
	363	2246	72.42	176.58	1.45	250.45
	720	4469	208.77	55.94	4.18	268.89
	381	2039	46.95	23.76	.94	71.65
	017	3985	6.31	2.48	.13	8.92
	103	6850	465.09	234.59	9.30	708.98

FIG. 87

STATE UNIVERSITY OF IOWA
BUSINESS OFFICE

PHYSICAL PLANT JOB VOUCHER

BUSINESS OFFICE COPY

NAME OF ACCOUNT Din. Serv. Capital Account

ACCOUNT NUMBER	JOB NUMBER	DESCRIPTION	DATE	EMPLOYEE OR REFERENCE NO.	LABOR HOURS	LABOR COST	MATERIALS COST	OVERHEAD COST	TOTAL COST
415	2463	LIGHT ON ELEVATOR MEMOR UNION	10 2 33						
415	2463	LIGHT	5 4 34	664		42 12			42 12
415	2463	LIGHT	5 4 34	3 664			28 76		28 76
415	2463	RETURNED MATERIAL	5 16 34	35 432			998 681		998 681
415	2463	OVERHEAD COST	5 31 34					2 11	2 11
						42 12	1 557	2 11	59 80

FIG. 88

Appendix

Section II—Codes

State University of Iowa Codification of Accounts

1 00 0 000	**OPERATING**
1 01 0 000	**Administration**
1 01 0 001	Administration Salaries
1 01 0 002	President's Office
1 01 0 003	Registrar's Office
1 01 0 004	Dean of Men
1 01 0 005	Dean of Women
1 01 0 006	Transcript Fees
1 01 0 007	
1 01 0 008	
1 01 0 009	
1 01 0 010	
1 02 0 000	**General Expense**
1 02 0 011	Assoc. Dues and Expenses
1 02 0 012	Printing and Bulletins
1 02 0 013	Pres. Office Printing
1 02 0 014	Business Office Printing
1 02 0 015	Commencement Expense
1 02 0 016	General Lectures
1 02 0 017	Incidentals Bus. Office
1 02 0 018	Incidentals Treas. Office
1 02 0 019	Incidentals Pres. Office
1 02 0 020	Incidentals Gen. Expense
1 02 0 021	Stamps and Postage
1 02 0 022	Publications Salaries
1 02 0 023	Publication Expense
1 02 0 024	News Service
1 02 0 025	Pres. Contingent Expense
1 02 0 026	Pres. Travel Fund
1 02 0 027	
1 02 0 028	
1 02 0 029	
1 03 0 000	**Student Service**
1 03 0 030	
1 03 0 031	Out-Patient Expense
1 03 0 032	Memorial Union Salaries
1 03 0 033	Memorial Union Expense
1 03 0 034	Employment Bureau
1 03 0 035	Housing Service
1 03 0 036	River Patrol Service
1 03 0 037	
1 03 0 038	Alumni Service Expense
1 03 0 039	
1 03 0 040	
1 04 0 000	**Physical Plant**
1 04 0 050	Salaries
1 04 0 051	Administration
1 04 0 052	Building Operation
1 04 0 053	Telephones and Telegraph
1 04 0 054	Truck Operation
1 04 0 055	Repair of Buildings
1 04 0 056	Campus
1 04 0 057	Fuel f.o.b. Mine
1 04 0 058	Fuel Freight
1 04 0 059	Steam Costs at Steam Header
1 04 0 060	Elec. Cost at Switchboard
1 04 0 061	Water Cost at Pump Header
1 04 0 062	Dis. Cost Heat, Elec. & Water
1 04 0 063	Underground System
1 04 0 064	Heat, Water & Elec. Invoiced to Departments
1 04 0 065	
1 04 0 066	
1 04 0 067	
1 04 0 068	
1 04 0 069	
1 05 0 000	**College of Engineering**
1 05 0 070	Salaries
1 05 0 071	Administration
1 05 0 072	Civil Engineering
1 05 0 073	Engineering Drawing
1 05 0 074	Electrical Engineering
1 05 0 075	Mechanical Engineering
1 05 0 076	Mechanics and Hydraulics
1 05 0 077	Coal Committee Salaries
1 05 0 078	Coal Committee Expense
1 05 0 079	
1 05 0 080	
1 06 0 000	**College of Liberal Arts**
1 06 0 100	Salaries
1 06 0 101	Administration
1 06 0 102	Botany
1 06 0 103	Chemistry
1 06 0 104	Geology
1 06 0 105	History
1 06 0 106	Home Economics
1 06 0 107	Journalism
1 06 0 108	Mathematics
1 06 0 109	Military Science
1 06 0 110	Philosophy
1 06 0 111	Physical Education Men
1 06 0 112	Physical Education Women
1 06 0 113	Physics
1 06 0 114	Political Science
1 06 0 115	Psychology
1 06 0 116	Speech
1 06 0 117	Speech Debate
1 06 0 118	Zoology
1 06 0 119	
1 06 0 120	

Codification of Accounts—Continued

1 06 1 000 School of Fine Arts

1 06 1 125 Administration
1 06 1 126 Graphic & Plastic Arts
1 06 1 127 Hist. & Apprec. of Fine Arts
1 06 1 128 Music
1 06 1 129 Dramatic Art Equipment
1 06 1 130 Graphic & Plastic Arts Equip.
1 06 1 131 Dramatic Art
1 06 1 132
1 06 1 133
1 06 1 134
1 06 1 135

1 06 2 000 School of Letters

1 06 2 140 English
1 06 2 141 German
1 06 2 142 Classical Languages
1 06 2 143 Romance Languages
1 06 2 144
1 06 2 145 Administration
1 06 2 146
1 06 2 147
1 06 2 148
1 06 2 149

1 07 0 000 Medicine

1 07 0 150 Salaries
1 07 0 151 Administration
1 07 0 152 Anatomy & Histology
1 07 0 153 Bio-chemistry
1 07 0 154 Dermatology
1 07 0 155 Dissecting Material
1 07 0 156 Gynecology & Obstetrics
1 07 0 157 Neurology
1 07 0 158 Ophthalmology
1 07 0 159 Orthopedic Surgery
1 07 0 160 Otolaryngology
1 07 0 161 Pathology
1 07 0 162 Pediatrics
1 07 0 163 Pharmacology
1 07 0 164 Physiology
1 07 0 165 Roentgenology
1 07 0 166 General Surgery
1 07 0 167 G U Surgery
1 07 0 168 Theory and Practice
1 07 0 169 Univ. Dept. of Health
1 07 0 170
1 07 0 171
1 07 0 172

1 08 0 000 Medicine Research

1 08 0 180 Salaries
1 08 0 181 Anatomy & Histology Res.
1 08 0 182 Gynecology & Obs. Res.
1 08 0 183 Ophthalmology Research
1 08 0 184 Pathology Research
1 08 0 185 Pediatrics Research
1 08 0 186 Pharmacology Research
1 08 0 187 Psychiatry Research
1 08 0 188 General Surgery Research
1 08 0 189 Orthopedic Surgery Research
1 08 0 190 Theory & Practice Research

1 09 0 000 Dentistry

1 09 0 200 Salaries
1 09 0 201 Dentistry Supplies
1 09 0 202 Dentistry Equipment
1 09 0 203 Dental Infirmary
1 09 0 204

1 10 0 000 Pharmacy

1 10 0 210 Salaries
1 10 0 211 Supplies
1 10 0 212

1 11 0 000 Law

1 11 0 220 Salaries
1 11 0 221 General Expense
1 11 0 222 Law Library Books
1 11 0 223 Law Library Equipment
1 11 0 224
1 11 0 225

1 12 0 000 Education

1 12 0 230 Salaries
1 12 0 231 General Expense
1 12 0 232 Publications
1 12 0 233 Appointment Committee
1 12 0 234 High School
1 12 0 235 Elementary School
1 12 0 236 Conference on Supervision
1 12 0 237 High School Conference
1 12 0 238
1 12 0 239

1 13 0 000 Commerce

1 13 0 240 Salaries
1 13 0 241 Supplies
1 13 0 242
1 13 0 243

1 14 0 000 Bureau of Business Res.

1 14 0 250 Salaries
1 14 0 251 Supplies
1 14 0 252
1 14 0 253

1 15 0 000 Graduate

1 15 0 260 Salaries
1 15 0 261 Administration
1 15 0 262 Res. Serv. & Equipment
1 15 0 263 Field Work
1 15 0 264 Lectures and Conferences
1 15 0 265 Learned Publications
1 15 0 266 Incidentals
1 15 0 267
1 15 0 268
1 15 0 269

1 16 0 000 Character Education

1 16 0 270 Character Educ. Salaries

Codification of Accounts—Continued

1 17 0 000 Library

1 17 0 280 Salaries
1 17 0 281 Supplies
1 17 0 282 Assistants
1 17 0 283 Books
1 17 0 284 Equipment
1 17 0 285 Library Shelves
1 17 0 286

1 18 0 000 Museum

1 18 0 290 Salaries
1 18 0 291 Supplies
1 18 0 292
1 18 0 293

1 19 0 000 Summer Session

1 19 0 300 Salaries
1 19 0 301 Supplies
1 19 0 302
1 19 0 303

1 20 0 000 Extension

1 20 0 310 Salaries
1 20 0 311 General Expense
1 20 0 312 Radio Broadcasting
1 20 0 313 Parent Training
1 25 1 314 Tuition (Current)
1 25 2 315 Tuition (Old)

1 21 0 000 Epidemiology and Bact.

1 21 0 317 Salaries
1 21 0 318 General Expense
1 21 0 319

1 22 0 000 Child Welfare

1 22 0 320 Salaries
1 22 0 321 General Expense

1 23 0 000 Maternal and Infant Hygiene

1 23 0 330 Medical Unit Salaries
1 23 0 331 Medical Unit Supplies
1 23 0 332 Dental Unit Salaries
1 23 0 333 Dental Unit Supplies

1 24 0 000 44th G. A. Dept. Equip.

1 24 0 322 Mech. Engineering Lab. Equip.
1 24 0 323 Journalism Equip.
1 24 0 324 Laundry Equip.
1 24 0 325 Library Equip.
1 24 0 326 Music Equip.
1 24 0 327 Publications Equip.
1 24 0 328 Roentgenology Equip.
1 24 0 329 Student Health Equip.

1 24 1 000 45th G. A. Dept. Equip.

1 24 1 334 Epidemiology & Bact. Equip.
1 24 1 335 Speech Clinic Equip.
1 24 1 336 Registrar's Office Equip.
1 24 1 337 Speech Equip.
1 24 1 338 Campus Course Libr. Equip.
1 24 1 339 L. A. Assembly Equip.
1 24 1 340 Business Office Equip.
1 24 1 341 Dramatic Art Equip.
1 24 1 342 Music Equip.
1 24 1 343
1 24 1 344

2 00 0 000 INCOME FUND A

2 00 0 350 General Stores
2 00 0 351 General Stores Overhead
2 00 0 352 Physical Plant Stores
2 00 0 353 Postal Stores
2 00 0 354 Drug Stores
2 00 0 355 Drug Stores Overhead

3 00 0 000 INCOME FUND B

3 01 0 000 Service Departments

3 01 0 360 Animal Account
3 01 0 361 Drafting Bureau
3 01 0 362 Physical Plant Job System
3 01 0 363 Laundry Service
3 01 0 364 Multigraph
3 01 0 365 Statistical Service
3 01 0 366

3 02 0 000 Miscellaneous Rev. Accts.

3 02 0 370 Payroll Distribution
3 02 0 371 Iowa Law Review
3 02 0 372 Iowa Vocational Board
3 02 0 373 Materials Testing Lab.
3 02 0 374 Freight Claim Adjust. Acct.
3 02 0 375 Revolving Advanced Funds
3 02 0 376 Suspense Account
3 02 0 377 Accounts Receivable
3 02 0 378
3 02 0 379

3 03 0 000 Auxiliary Enterprises

3 03 1 000 HOSPITALS
3 03 1 380 Gen. & Children's Hosp.
3 03 1 381 Psychopathic Hosp.
3 03 1 382
3 03 1 383
3 03 1 384

3 03 2 000 Serology

3 03 2 385 Salaries
3 03 2 386 General Expense
3 03 2 387 Special Exams
3 03 2 388
3 03 2 389

3 03 3 000 Dormitory House Operation

3 03 3 390 Men's Dormitory
3 03 3 391 Men's Dorm. Student Laundry
3 03 3 392 Men's Dorm. Barber Shop
3 03 3 393 Currier Hall for Women
3 03 3 394 Eastlawn for Women
3 03 3 395 Field House Dorm.
3 03 3 396 Kellogg House
3 03 3 397 26 E. Jefferson
3 03 3 398 Whetstone House
3 03 3 399 Feeney House
3 03 3 400 Howard House
3 03 3 401 Capital Account
3 03 3 402 I. M. U. House Operation
3 03 3 403

3 03 4 000 Dining Service Operation

3 03 4 410 Quadrangle Cafeteria
3 03 4 411 Currier Hall Dining Room
3 03 4 412 Eastlawn Dining Room
3 03 4 413 Memo. Union Dining Serv.
3 03 4 414 High School Cafeteria
3 03 4 415 Din. Serv. Cap. Account
3 03 4 416
3 03 4 417

3 03 5 000 Other Accounts

3 03 5 420 Donated Land
3 03 5 421 Tenant Property
3 03 5 422 Maher Farm Operation
3 03 5 423 Beard Farm Operation
3 03 5 424 Butler Farm Operation
3 03 5 425 Donahoe Farm Operation
3 03 5 426 Loney Farm Operation
3 03 5 427 Skay Farm Operation
3 03 5 428 McCabe Farm Operation
3 03 5 429 Floerschinger Farm Oper.
3 03 5 430 Gen. Admin. Farm Group
3 03 5 431 Farnsworth Farm Oper.
3 03 5 432
3 03 5 433
3 03 5 435 Summer Session Camp

3 03 6 000 Extension Activities

3 03 6 440 Correspondence Study
3 03 6 441 Educational Tests
3 03 6 442 High School Contests
3 03 6 443 Music Festival
3 03 6 444 Academic Meet

4 00 0 000 TRUST FUNDS

4 1 0 0 000 Endowment Income

4 1 1 0 000 For Educ. & General Purposes

4 1 1 0 460 Mark Ranney Memorial Fund
4 1 1 0 461 Library Fine Fund
4 1 1 0 462 Scien. Fd. Col. Medicine
4 1 1 0 463
4 1 1 0 464

4 1 2 0 000 For Non-Educational Purposes

4 1 2 1 000 SCHOL. FELLOW. & PRIZES

4 1 2 1 470 Laffey Scholarship
4 1 2 1 471 Carr Scholarship
4 1 2 1 472 Dillon Scholarship Law
4 1 2 1 473 Bryan Prize Fund
4 1 2 1 474 Johnson Memorial Prize
4 1 2 1 475 Lefevre Memorial Prize
4 1 2 1 476 Belle & David Wyland Schp.
4 1 2 1 477 Sanxay Fellowship & Loan
4 1 2 1 478 Lowden Oratorical Prize
4 1 2 1 479 Lowden Orat. Prize Res. Fd.
4 1 2 1 480 Proudfoot Prize
4 1 2 1 481 Denkmann Law Scholarship
4 1 2 1 482

4 1 2 2 000 Miscellaneous Non-Educational

4 1 2 2 490 Gifford Memorial
4 1 2 2 491 Finkbine Dinner for Men
4 1 2 2 492 Finkbine Dinner for Women
4 1 2 2 493 Interest on Endowment Funds
4 1 2 2 494
4 1 2 2 495

4 2 0 0 000 Other Current Restricted Funds

4 2 1 0 000 EDUCATIONAL & GENERAL
4 2 1 1 000 MEDICAL FEES
4 2 1 1 500 Gyn. & Obs. Fees
4 2 1 1 501 Pediatrics Fees
4 2 1 1 502 Psychiatry Fees
4 2 1 1 503 Theory & Practice Fees
4 2 1 1 504 Ophthalmology Fees
4 2 1 1 505 Eye Clinic Fees
4 2 1 1 506 Roentgenology Fees
4 2 1 1 507 Pathology Fees
4 2 1 1 508
4 2 1 1 509

4 2 1 2 000 Research Gifts

4 2 1 2 514 Clin. Properties of Dextrose
4 2 1 2 515 Train. Full Time Candidates
4 2 1 2 516 Carn. & Harv. for Fine Arts
4 2 1 2 517 Payne Study & Exper. Fund
4 2 1 2 518 Carn. Corp. Res. in Art
4 2 1 2 519 Meier Art Tests
4 2 1 2 520 Amer. Historical Assoc.
4 2 1 2 521 Physiology of the Brain
4 2 1 2 522 Sex Research
4 2 1 2 523 Repr. Cycles in Plants
4 2 1 2 524 Quaker Oats Calc. Metab.
4 2 1 2 525 Mead Johnson Infant Metab.
4 2 1 2 526 Liver Proteins
4 2 1 2 527 Gift for Dept. Libraries
4 2 1 2 528 Vitamin E. Research
4 2 1 2 529 Blue-Green Algæ Research
4 2 1 2 530 Fleischmann Yeast Co.
4 2 1 2 531 Anti Oxygen Research
4 2 1 2 532 Adv. of Teaching—Carnegie
4 2 1 2 533 Student Health Visitations
4 2 1 2 534 Special Art Fund

4 2 1 3 000 School of Religion

4 2 1 3 535 Rockefeller Fund
4 2 1 3 536 Protestant Fund
4 2 1 3 537 Jewish Fund
4 2 1 3 538

4 2 1 4 539 Laura Spelman Memorial

4 2 1 4 540 905-A Coop. Projects Sal.
4 2 1 4 541 905-A Coop. Projects Exp.
4 2 1 4 542 905-B Curr. Study Sal.
4 2 1 4 543 905-B Curr. Study Exp.
4 2 1 4 544 905-C Child Develop. Sal.
4 2 1 4 545 905-C Child Develop. Exp.
4 2 1 4 546 905-D State Organ. Sal.
4 2 1 4 547 905-D State Organ. Exp.

4 2 1 5 000 Miscellaneous

4 2 1 5 550 Convocations & Publ. Events
4 2 1 5 551 Rom. Lang. Exp. Fund
4 2 1 5 552 Classical Languages
4 2 1 5 553 Institute of Hydraulic Res.
4 2 1 5 554 Special Stream Gaging
4 2 1 5 555

4 2 2 0 000 For Non-Educational Purposes

4 2 2 1 000 FELLOWSHIPS & SCHOLARSHIPS
4 2 2 1 560 Eastman Scholarship
4 2 2 1 561 Garvin Scholarship
4 2 2 1 562 Kings Daughters & Sons Schp.
4 2 2 1 563 Swaine Scholarship in Har.
4 2 2 1 564 Mead Johnson Co. Vitamin B.
4 2 2 1 565 Edward Bartow Chem. Schp.
4 2 2 1 566 Hammond Law Scholarship
4 2 2 1 567 Diamond Law Scholarship
4 2 2 1 568 Miller Law Scholarship
4 2 2 1 569 Wright Law Scholarship
4 2 2 1 570 Adler Scholarship in Journ.
4 2 2 1 571 Brewer Journalism Prize
4 2 2 1 572

4 3 0 0 000 Agency Funds

4 3 0 0 580 Ent. of Crippled Children
4 3 0 0 581 U. S. Gov't. Uniform Acct.
4 3 0 0 582 Military Band Uniforms
4 3 0 0 583 Military Deposits
4 3 0 0 584 Laboratory Deposits
4 3 0 0 585 H.S. Locker Deposits
4 3 0 0 586 H.S. Shop Deposits
4 3 0 0 587 H.S. Book Deposits
4 3 0 0 588 Gym. Locker Deposits
4 3 0 0 589 Library Desk Deposits
4 3 0 0 595 Alumni Association
4 3 0 0 596 Auto Acct.—Alumni Assoc.
4 3 0 0 597 Alumni Assoc. Life Membs'p
4 3 0 0 598 Plate Fund—Alumni Assoc.
4 3 0 0 599 Medical Aptitude Tests
4 3 0 0 600 Character Educ. Author Fund
4 3 0 0 601 Student Advance Tuition
4 3 0 0 602 Homecoming Committee
4 3 0 0 603

4 3 0 0 609 Student Organizations

4 3 0 0 610 A. F. I.
4 3 0 0 611 Alpha Phi Omega
4 3 0 0 612 All Univ. Men's Dinner
4 3 0 0 613 All Univ. Women's Dinner
4 3 0 0 614 Assoc. Students of Engr.
4 3 0 0 615 Assoc. Students of Journ.
4 3 0 0 616 Athena Literary Society
4 3 0 0 617 Band Fund
4 3 0 0 618 Barristers Ball
4 3 0 0 619 Beta Gamma Sigma
4 3 0 0 620 Classical Club
4 3 0 0 621 Class 1934—Medicine
4 3 0 0 622 Commerce Club
4 3 0 0 623 Commerce Mart
4 3 0 0 624 Continuo Club
4 3 0 0 625 Cosmopolitan Club
4 3 0 0 626 Currier Hall Assoc.
4 3 0 0 627 Dance Drama
4 3 0 0 628 Delta Sigma Rho
4 3 0 0 629 Dolphin Club
4 3 0 0 630 Eastlawn Assoc.
4 3 0 0 631 Eurodelphian Literary Soc.
4 3 0 0 632 Eta Sigma Phi
4 3 0 0 633
4 3 0 0 635
4 3 0 0 636 Freshman Engineers
4 3 0 0 637 Freshman Party Class 1935
4 3 0 0 638 Freshman Party Class 1936
4 3 0 0 639
4 3 0 0 640
4 3 0 0 641
4 3 0 0 642 Gamma Epsilon Pi
4 3 0 0 643 German Club
4 3 0 0 644 Glider Club
4 3 0 0 645 Graduate Club
4 3 0 0 646
4 3 0 0 648
4 3 0 0 649 Hamlin Garland Literary Soc.
4 3 0 0 650 H.S. Debating League
4 3 0 0 651 Homecoming Party
4 3 0 0 652 Home Economics Club
4 3 0 0 653
4 3 0 0 655
4 3 0 0 656 I Blanket Hop
4 3 0 0 657 Inter Collegiate Debate
4 3 0 0 658 Inter Fraternity Council
4 3 0 0 659 Inter Professional Sorority
4 3 0 0 660 Iota Sigma Pi
4 3 0 0 661 Iowa Dames Club
4 3 0 0 662 Iowa Publisher
4 3 0 0 663 Iowa Law Students Assoc.
4 3 0 0 664 Irving Institute
4 3 0 0 665
4 3 0 0 666
4 3 0 0 667
4 3 0 0 668 Junior College Conference
4 3 0 0 669 Junior Prom Class 1934
4 3 0 0 670
4 3 0 0 671
4 3 0 0 672 Kellogg Co-operative
4 3 0 0 673
4 3 0 0 674 May Frolic
4 3 0 0 675 Mecca Ball

4 3 0 0 676	Medical Student Council
4 3 0 0 677	Men's Forensic Council
4 3 0 0 678	Mortar Board
4 3 0 0 679	Military Ball
4 3 0 0 680	Mothers Day Dinner
4 3 0 0 681	
4 3 0 0 682	
4 3 0 0 683	
4 3 0 0 684	Newman Club
4 3 0 0 685	
4 3 0 0 686	
4 3 0 0 687	Octave Thanet Literary Soc.
4 3 0 0 688	Omicron Nu
4 3 0 0 689	Order of Artus
4 3 0 0 690	
4 3 0 0 691	
4 3 0 0 692	Pan Hellenic Party
4 3 0 0 693	Pep Jamboree
4 3 0 0 694	Pershing Rifles
4 3 0 0 695	Pershing Rifles 2nd Regiment
4 3 0 0 696	Phi Beta Kappa
4 3 0 0 697	Phi Delta Gamma
4 3 0 0 698	Phi Epsilon Kappa
4 3 0 0 699	Phi Gamma Nu
4 3 0 0 700	Phi Lambda Upsilon
4 3 0 0 701	Phi Sigma Iota
4 3 0 0 702	Pica Ball
4 3 0 0 703	Physical Education—Circus
4 3 0 0 704	Phi Epsilon Pi
4 3 0 0 705	Philo Club
4 3 0 0 706	Philomathian Literary Soc.
4 3 0 0 707	
4 3 0 0 710	
4 3 0 0 711	Quadrangle Association
4 3 0 0 712	
4 3 0 0 713	Rhoterian Forensic
4 3 0 0 714	R.O.T.C. Unit Fund
4 3 0 0 715	
4 3 0 0 717	
4 3 0 0 718	Scabbard & Blade
4 3 0 0 719	Seals Club
4 3 0 0 720	Senior Memorial 1927
4 3 0 0 721	Senior Memorial 1928
4 3 0 0 722	Senior Memorial 1929
4 3 0 0 723	Senior Memorial 1930
4 3 0 0 724	Senior Memorial 1931
4 3 0 0 725	Senior Memorial 1932
4 3 0 0 726	Senior Memorial 1933
4 3 0 0 727	Senior Memorial 1934
4 3 0 0 728	Senior Hop Class
4 3 0 0 729	Sigma Delta Chi
4 3 0 0 730	Sigma Delta Phi
4 3 0 0 731	Sophomore Cotillion
4 3 0 0 732	Student Council
4 3 0 0 733	Student Sports—Swimming
4 3 0 0 734	Student Sports—Ice Skating
4 3 0 0 735	Student Sports—Track
4 3 0 0 736	Student Sports—Baseball
4 3 0 0 737	Student Sports—Wrestling
4 3 0 0 738	
4 3 0 0 739	
4 3 0 0 740	
4 3 0 0 741	
4 3 0 0 742	Tau Beta Pi
4 3 0 0 743	Theta Sigma Phi
4 3 0 0 747	Union—University Party
4 3 0 0 748	Univ. Elementary School
4 3 0 0 749	Univ. High School
4 3 0 0 750	Union Board
4 3 0 0 751	University Players
4 3 0 0 752	University Theatre
4 3 0 0 753	
4 3 0 0 754	
4 3 0 0 755	
4 3 0 0 756	
4 3 0 0 757	Whitby Literary Society
4 3 0 0 758	Women's Athletic Assoc.
4 3 0 0 759	Women's Executive Council
4 3 0 0 760	Women's Forensic Council
4 3 0 0 761	Women's Pan Hellenic Council
4 3 0 0 762	
4 3 0 0 763	
4 3 0 0 764	
4 3 0 0 765	Y.M.C.A.
4 3 0 0 766	Y.W.C.A.
4 3 0 0 767	
4 3 0 0 768	
4 3 0 0 769	Zetagathian Literary Soc.
4 3 0 0 770	
4 3 0 0 771	Campus Camera Club
4 3 0 0 772	Feeney Co-op.
4 3 0 0 773	Howard Co-op.
4 3 0 0 774	Jefferson Co-op.
4 3 0 0 775	
4 3 0 0 776	Whetstone Co-op.
4 3 0 0 777	
5 0 0 0 000	**LOAN FUNDS**
5 2 4 0 800	Undergraduate Student Loan
5 2 4 0 801	A. Whitney Carr Grad. Loan
5 2 4 0 802	Law Consolidated Loan
5 2 4 0 803	Cosmopolitan Loan
5 2 4 0 804	F. C. Denkman Loan in L.A.
5 2 4 0 805	Finkbine Loan for Men
5 2 4 0 806	Finkbine Loan for Women
5 2 4 0 807	Keokuk Rotary Club Loan
5 2 4 0 808	Robert T. Swaine Grad. Loan
5 2 4 0 809	Medical College Loan
5 2 4 0 810	Student Nurses Org. Loan
5 2 4 0 811	Women's Assoc. Loan
5 2 4 0 812	Home Economics Club Loan
5 2 4 0 813	Alumni Assoc. Loan
5 2 4 0 814	
5 2 4 0 815	
6 0 0 0 000	**CAPITAL FUNDS**
6 1 00 000	**General Improvement 44th G.A.**
6 1 11 000	BUILDING & EQUIPMENT
6 1 11 830	Mechanical Engr. Laboratory
6 1 11 831	Add. to Isolation Hosp.
6 1 11 832	Boiler Feed Pump
6 1 11 833	Improvements to Chem. Bldg.
6 1 11 834	Remod. Hosp. Room for x-ray
6 1 11 835	Water Back for Boiler No. 8
6 1 11 836	Water Feed Meter & CO_2 Meter
6 1 12 000	ELECTRIC SERVICE LINES & EQUIPMENT
6 1 12 837	Lights along Templin Road

Codification of Accounts—Continued

6 1 12 838	Lighting Improvement & District System
6 1 13 000	GRADING & OTHER CAMPUS IMPROVEMENTS
6 1 13 839	Exhaust Steam Line to W. Side
6 1 13 840	Balustrades—Burlington St. & Iowa Ave.
6 1 14 000	PAVING SIDEWALKS & SEWERS
6 1 14 841	New Medical Lab. Sidewalks
6 1 14 842	Psycho. Hosp. Sewer
6 2 00 000	**General Improvement 45th G.A.**
6 2 11 000	BUILDINGS & EQUIPMENT
6 2 11 843	
6 2 11 844	
6 2 11 848	
6 2 11 849	
6 2 11 850	
6 2 12 000	ELEC. SER. LINES & EQUIP.
6 2 12 856	
6 2 12 857	
6 2 12 858	
6 2 12 859	
6 2 12 860	
6 2 12 861	
6 2 13 000	GRADING & OTHER CAMPUS IMPR.
6 2 13 866	Steam Line—Power Plant to M. E. Lab.
6 2 13 867	
6 2 13 868	
6 2 13 872	
6 2 13 873	
6 2 14 000	PAVING, SIDEWALKS & SEWERS
6 2 14 874	Elm Street Sewer
6 2 14 875	East Side Tunnel
6 2 14 876	
6 2 14 877	
6 2 14 878	
6 2 14 879	
6 2 14 880	
6 3 00 000	**Fine Arts Building**
6 3 00 881	Investment Account
6 3 00 882	Income from Investment
6 3 00 883	Building Account
6 4 00 884	**Psychopathic Hospital Add.**
6 5 00 885	**Central Garage**
6 6 00 886	**Purchase of Land**

State University of Iowa Expense Classification

Part I, is a general expense classification applying to all accounts.

Part II, is a supplemental classification applying to a few specific large accounts.

The first pair of numbers indicates the general classification.

The second pair of numbers indicates the supplemental classification.

The combination of general and supplemental numbers cover most cases, but any general number may be combined with any supplemental number where the combination listed does not strictly apply.

PART I

General Classifications

01 00	Office Expense—(Including stationery, office supplies, freight, express, drayage, advertising, postage, telephone and telegraph.)
02 00	Printing
03 00	Travel (Except Hosp. Patients 04)
04 00	Departmental Supplies (Except foodstuffs -11) Not included under Office Expense.
05 00	Repairs
06 00	Wages of Temporary Employees
07 00	Salaries of All Regular Appointees
08 00	Unclassified Expenditures
09 00	Equipment
10 00	Permanent Improvements
11 00	Foodstuffs
12 00	Heat, Electricity, Water and Gas
13 00	Laundry

PART II

Supplemental Classifications

GROUNDS AND BUILDINGS

Building Operations

06 01 Janitors' Salaries
04 02 Janitors' Supplies
12 03 Gas and Electricity
12 04 Water, Ice and Chemist
13 05 Laundry
06 06 Moving
04 07 Pools
04 08 Salt
09 09 Equipment
08 10 Hydrant Rental
08 11 Insurance

Truck Operation

05 01 Supplies and Repairs
04 02 Tires
04 03 Gasoline and Oil
06 04 Labor

Building Repair

05 01 General Repairs
05 02 Plumbing
05 03 Heating
05 04 Painting and Glazing
05 05 Roofs
05 06 Elevators
05 07 Machine Shop
05 08 Carpenter Shop
09 09 Equipment
10 10 Permanent Improvement
06 11 Overhead Salaries
06 12 Med. Lab. House Mechanic
05 13 Shades, Keys and Fire Equipment
06 14 Plasterer and Helper
05 15 Hospitals
05 16 Electric Service in Buildings

Underground System

04 01 Tunnel
04 02 Water Mains
04 03 Sewer

Steam Costs at Steam Header

06 01 Unloading Coal
06 02 Coal Testing Labor
04 03 Testing, Lab. Equip., Print., etc.
04 04 Softeners, Boiler Feed
04 05 Lime
04 06 Soda
12 07 Make-up Water (Purchased Water)
06 08 Boiler Room Engineer
06 09 Boiler Room Asst. Engineer
06 10 Boiler Room Electrician
06 11 Boiler Room Repair Men
06 12 Boiler Room Pump Men
06 13 Boiler Room Larry Men
06 14 Boiler Room Firemen
06 15 Boiler Room Ashmen
06 16 Boiler Room Softener Man
06 17 Boiler Room Cinder Disposal
06 18 Boiler Room Unclass. Extra Labor
05 35 Reducing Pressure Valves
05 20 Boiler Repair, Furnace, Stokers
05 21 Coal Conveyor
05 22 Ash Hoist
05 23 Stoker Drives
05 24 Boiler Feed Pumps
05 25 Traps
05 26 Water Softeners
05 27 Gauges and Meters
05 28 Tools, Belting, etc.
05 29 Charts
05 30 Oil and Grease
05 31 Waste and Janitor Supplies
05 32 Lamps
05 33 House Pumps
05 34 Unclass. Material and Labor
05 19 Sewer Pumps

Electric Costs at Switchboard

06 36 Dynamo Tenders
06 37 Engineer
06 38 Assistant Engineer
06 39 Electrician
06 40 Repair Men
06 41 Pump Men
06 42 Softener Man
06 43 Unclass. Extra Labor
04 44 Turbines
04 45 Hydro Unit
04 46 Condensers and Pumps
04 47 Charts
04 48 Gas and Oil
04 49 Tools, Waste, etc.
04 50 Lamps
04 51 Revolving Screen
04 52 Unclassified
12 53 Purchase and Sale of Electricity

Water Costs at Pump Header

06 54 Labor Costs—Engineer
06 55 Labor Costs—Asst. Engineer
06 56 Labor Costs—Electrician
06 57 Labor Costs—Pump Men
06 58 Labor Costs—Filter Operators
06 59 Labor Costs—Unclassified
05 60 Repairs—Service Pumps
05 61 Repairs—Filter Plant Pumps
05 62 Repairs—Compressors
05 63 Repairs—Lamps
05 64 Repairs—Filter Repairs
05 65 Repairs—Chart, Records, Meters
05 66 Repairs—Unclassified
04 67 Materials—Alum
04 68 Materials—Chlorine
04 69 Materials—Other Chemicals

04 70 Soft Water Zeolite—Salt
04 71 Soft Water Zeolite—Unclass. Labor and Material
04 72 Lime

Heat Distribution Costs

06 73 Labor—Steamfitter Chief
06 74 Labor—Tunnel Patrol
06 75 Labor—Pipe Covering Tunnels
06 76 Labor—Unclassified
04 77 Material—Traps, R.P.V., Valves
04 78 Material—Covering
04 79 Material—Expansion Joints
04 80 Material—Htg. Plant No. 3 Pumps
04 81 Material—Htg. Plant No. 2 Pumps
04 82 Material—Lamps
04 83 Material—Unclassified

Electric Distribution Costs

06 85 Labor—Electrician Chief
06 86 Labor—Unclassified
04 87 Materials & Repr.—Cables, Fuses
04 88 Materials & Repr.—Lamps Tunnel
04 89 Materials & Repr.—Meters, etc.
04 90 Materials & Repr.—Transformers
04 91 Materials & Repr.—Unclassified

Water Cost of Distribution

06 93 Labor—Chief Plumber
06 94 Labor—Unclassified
04 95 Materials & Repr.—Pipes, Valves
04 96 Materials & Repr.—Lamps Tunnel
04 97 Materials & Repr.—Meters, Charts
04 98 Materials & Repr.—Unclassified

GENERAL STORES

11 01 Groceries (Bulk)
11 02 Canned Goods
11 03 Potatoes
11 04 Meats
04 05 Gas and Oil
04 06 Ice Purchased
04 07 General Merchandise
07 10 Administrative Salaries
06 11 Clerical Salaries
01 12 Office Supplies
04 13 General Supplies
05 14 General Repairs
01 15 Telephone
13 16 Laundry
12 17 Heat
09 18 General Equipment
06 19 General Salaries
12 20 Electricity
12 21 Water
04 22 Ice Delivery Supplies and Expense
05 23 Ice Machine Repairs
06 24 Wages of Ice Machine Attendant
04 30 Gas and Oil for Trucks
04 31 Tires and Tire Repair
05 32 Truck Repairs and Replacement
04 33 Truck Supplies
06 34 Wages of Truck Drivers

IOWA MEMORIAL UNION DINING SERVICE

07 01 Administration Salaries
06 02 Gen. Salaries and Labor
06 03 Meal Help
11 10 Groceries
11 11 Meat
11 12 Bakery Supplies
11 13 Milk
11 14 Ice Cream
12 20 Gas
13 21 Laundry
12 22 Heat, Light and Water
04 23 Ice
04 30 General Supplies
05 31 Repair and Replacement
07 40 Fountain Admin. Salaries
06 41 Fountain Gen. Sal. and Labor
11 42 Fountain Foods
05 43 Fountain Repair and Replacement
04 44 Fountain General Expense
04 50 Lobby and Candy Counter Supplies
06 51 Lobby and Candy Counter Wages

TENANT PROPERTY AND DONATED LAND

08 01 Insurance
05 05 Repairs
08 02 Legal Expense
12 12 Heat, Light, Water and Gas
10 10 Capital
09 09 Equipment
08 08 Unclassified

UNION HOUSE OPERATION

Lounge Room Rentals

06 01 Labor
04 02 Supplies
09 03 Equipment
08 04 Insurance

Maintenance Fund (Gen. Furniture)

06 11 Labor
04 12 Supplies
09 13 Equipment
08 14 Insurance
08 15 Rent
08 16 Investment

UNIVERSITY HOSPITAL

07 01 Salaries
04 02 Supplies
09 03 Equipment
05 04 Repairs
08 05 Insurance
02 06 Printing
03 07 Employees' Travel
01 08 Postage
01 09 Telephone
01 10 Telegraph
07 11 School of Nursing Salaries
09 12 Equip. & Replace't—Professional
09 13 Equip. & Replace't—Housekeeping
07 14 Pathology Salaries

04 15 Pathology Supplies
07 16 Anaesthesia Salaries
04 17 Anaesthesia Supplies
09 18 Anaesthesia Equipment
05 19 Anaesthesia Repairs
07 20 Serology Lab. Salaries
07 21 Physical Therapy Salaries
07 22 Social Service Salaries
07 23 Psycho. Test Salaries
07 24 Internes Salaries
04 25 Internes Supplies
07 26 X-Ray Salaries
04 27 X-Ray Supplies
09 28 X-Ray Equipment
05 29 X-Ray Repairs
07 30 Pathological Chemistry Salaries
07 31 Nutrition Salaries
04 32 Nutrition Supplies
09 33 Nutrition Equipment
05 34 Nutrition Repairs
11 35 Nutrition Foods
07 36 Housekeeping Salaries
09 37 Housekeeping Equipment
05 38 Housekeeping Repairs
04 39 Bedding
04 40 Textiles, Muslins, etc.
04 41 Cleaning Supplies
04 42 Miscellaneous Supplies
07 43 Perkins School Salaries
04 44 Perkins School Supplies
07 45 Maintenance & Repair Salaries
07 46 Occupational Therapy Salaries
04 47 Occupational Therapy Supplies
04 48 Building Supplies
09 49 Building Equipment
05 50 Building Repairs
07 51 Brace Shop Salaries
04 52 Brace Shop Supplies
09 53 Brace Shop Equipment
05 54 Brace Shop Repairs
07 55 Store Room Salaries
07 56 Bandage Room Salaries
07 57 Barbers' Salaries
04 58 Drugs and Biologicals
04 59 Blood Donors
04 60 Surgical and Nursing Instruments
04 61 Surgical and Nursing Supplies
09 62 Surgical and Nursing Equipment
05 63 Surgical and Nursing Repairs
04 64 Ascheim Zondek Test Supplies
04 65 Ambulance and Truck
13 66 Laundry
01 67 Freight
01 68 Express
12 69 Gas
12 70 Electricity
12 71 Heat
12 72 Water
04 73 Corrective Apparatus—Orthopedics
04 74 Corrective Apparatus—General
04 75 Corrective Apparatus—Optical
04 76 Patients' Wearing Apparel
04 77 Professional Staff Wearing Apparel
04 78 Internes' Wearing Apparel
04 79 Employees' Wearing Apparel
04 80 Photos
04 81 Railroad Fare, Taxi, Escort Sal.
09 82 Auto Equipment—New
05 83 Auto Repairs, Tires, etc.
04 84 Auto Supplies, Gas and Oil
07 85 Drivers' Salaries
08 86 Doctors' Examination Fees
04 87 Water Softener Supplies
03 88 Travel Expense—Social Service
08 89 Refunds to Patients
07 90 Lab. Assts.—Internal Medicine
09 91 Pasteurizing Plant

PSYCHOPATHIC HOSPITAL

01 01 Office Expense
02 02 Printing
04 03 Industrial Supplies (Occupational)
07 04 Clerical Salaries
04 05 Laboratory Supplies (Not Medical)
07 06 Laboratory Salaries
07 10 Medical Salaries
07 11 Nursing Salaries
04 12 Drugs
04 13 Medical Supplies
04 14 Transportation of Patients
08 15 Refunds to Patients
04 20 Housekeeping Supplies
07 21 Housekeeping Salaries
11 22 Foods
13 23 Laundry
01 24 Freight and Express
12 25 Heat, Light, Water and Gas
08 26 Rent
03 27 Employees' Travel Expense
05 28 Building and Equipment Repairs
04 29 Care of Grounds
09 30 Equipment

DORM. AND DIN. SERVICE (Except Union)

01 01 Office Expense
04 04 General Supplies
05 05 Repairs
06 06 Wages of Temporary Employees
07 07 Salaries of Regular Appointees
08 08 Unclassified Expenditures
09 09 Equipment
10 10 Permanent Improvements
11 11 Foodstuffs
12 12 Heat, Elec., Water and Gas
13 13 Laundry
01 14 Telephones
08 15 Refunds of Board or Room
08 16 Refunds of House Deposits

STUDENT ORG. (Except Theatre)

06 01 Orchestras
04 02 Decorations
02 03 Tickets
01 04 Advertising
08 05 Lounge Room Rental
08 06 Tax
02 07 Programs
01 08 Telegraph
01 09 Telephones
12 10 Heat, Elec., Water and Gas

Expense Classification—Continued

09 11 Equipment
04 12 General Supplies
11 13 Foodstuffs
13 14 Laundry
01 15 Office Supplies
01 16 Subscriptions
04 17 Luncheons and Dinners
04 18 Refreshments
01 19 Postage
08 20 Organization Dues
04 21 Organization Emblems and Cups
03 22 Traveling Expense
04 23 Smokers
08 24 Senior Memorials
06 25 Clerical Salaries
06 26 Part Time Labor
02 27 Publication
08 28 Unclassified Expenditures
06 29 Service Charge
08 30 Refunds
05 31 Repairs
08 32 Game Guarantee

UNIVERSITY THEATRE

08 01 Royalties
04 02 Scenery and Properties
04 03 Costumes
01 04 Publicity
01 05 Programs and Office Supplies
06 06 Music
04 07 Children's Theatre
04 08 Experimental Productions
06 09 Technical and Clerical Help
07 10 Salaries

State University of Iowa Classification of Departmental Equipment

1000 LABORATORY APPARATUS
1010 Unclassified
1011 Drawing Instruments and Apparatus
1012 Arms, et cetera

1020 Electrical Apparatus

1021 Generative and Electromotive Apparatus and Machinery
1022 X-Ray, Violet ray, et cetera
1023 Dynamos, generators, motors
1024 Transformers
1025 Rheostats
1026 Induction coils, ammeters, galvanometers
1027 Heating apparatus including furnaces, ovens, hot plates, and incubators
1028 Telegraph, telephone, and radio apparatus
1029 Illuminating apparatus and machinery

1030 Steam Apparatus

1040 Gas and Combustion Machinery

1041 Engines

1050 Optical Apparatus

1051 Microscopes
1052 Microscope attachments and accessories including objectives, oculars, magnifying glasses, stages, nose pieces, camera lucida, illuminators, stands, lenses, and other equipment. (Exclude camera lenses.)
1053 Telescopes and reticles.
1054 Transits, levels, compasses, and surveying equipment
1055 Field Glasses, binoculars
1056 Lanterns, projectors, stereoscopes, delineascopes, etc.
1057 Cameras, and general photographic apparatus
1058

1060 Mechanical Apparatus

1061 Shop Machinery including lathes, planers, and sharpeners, drilling and boring machinery, grinding machines, punches, presses, and forges.
1062 Printing Machinery

1070 Testing Machinery

including centrifuges, weighing scales exclusive of laboratory balances.

1080 General Laboratory Apparatus

1081 Scales and balances, with weights
1082 Timing, recording, and measuring devices including stop watches, chronometers, thermometers, barometers, meters (other than electrical and steam), gauges, etc.
1083 Platinum and illium ware
1084 Slide rules, calculating instruments, etc.
1085 Microtomes and freezing attachments
1086 Medical and Dental apparatus including dissecting, analytical, diagnostic, operating, and surgical instruments
1087 Sterilizers

1090 Charts and Maps (including globes)

1100 Slides and Films. (Those loaned by the Extension Department but not those in general use in a department)
1111 Pianos and Organs
1112 Band and orchestral instruments
1113 Phonographs and accessories

2000 FURNITURE AND FIXTURES

2010 Chairs (all kinds)

2011 Dental chairs

Equipment Classification—Continued

2020 Stools
2030 Office Desks. (All kinds)
2040 Laboratory desks including lecture desks, stands, and laboratory benches
2050 Tables. (All kinds)
2060 Cases, cabinets, cupboards including sorting equipment, book cases (except stacks and shelves); key cases, medicine cases, show cases, herbarium and specimen cases; emergency cabinets and kits; periodical, stationery, and newspaper racks; music cabinets, chests, drawers, etc.
2070 Filing equipment, including letter, check storage, catalogue and other files; card index systems, tops, bases and parts; pamphlet cases, addressograph plate files; visible filing equipment and registers
2080 Lockers, wardrobes
2090 Shelving, including book stacks
2100 Rugs, Mats, etc.
2110 Decorations, including pictures, photographs, frames and paintings
2111 Statuary, casts, and art objects
2112 Clocks (Except time recording apparatus)
2113 Lamps and movable light fixtures
2114 Screens, awnings, ornaments, tents, etc.
2120 Household Furnishings (Exclusive of tables, chairs and other classified articles)
2121 Couches, beds, lounges, and davenports
2122 Costumers, umbrella stands, dressers, mirrors, water coolers
2130 Miscellaneous—dictionary stands, pedestals, easels, etc.
2140 Bulletin boards and blackboards
2150 Bulky, unclassified articles
2160 Household Machinery, sewing machines, and kitchen machinery
2161 Small kitchen ware (lumped)
2162 Dishes, silverware, etc.
2170 Safes
2180 Refrigerators, freezers, and ice machines
2190 Stoves, furnaces, and heaters
2191 Cookers, pressure; coffee urns

3000 OFFICE EQUIPMENT

3010 Typewriters—Underwood
3011 Typewriters—Royal
3012 Typewriters—L. C. Smith
3013 Typewriters—Remington
3014 Typewriters—Hammond
3015 Typewriters—Miscellaneous
3020 Adding and calculating machines
3030 Duplicators including mimeographs, hektographs, ditto machines and multigraphs
3040 Dictating machines
3050 Mailing equipment including addressing machines, sealers, and postage scales
3060 Electric fans
3070 Telephones (intercommunicating) and buzzers
3080 Miscellaneous devices including perforators, punches, check writers, paper cutters, time recorders, money change racks, etc.
3090 Cash registers and checkers

4000 BOOKS

5000 MACHINERY AND TOOLS

(not laboratory equipment)
5010 Electrical Machinery
5011 Generative and electromotive apparatus and machinery
5012 Elevators
5013 Dynamos, generators, batteries, and motors
5014 Testing, measuring, reducing, regulating devices and machines, including ammeters, galvanometers, and induction coils
5015 Transformers
5016 Rheostats
5017 Heating apparatus, including furnaces and ovens
5018 Illuminating machinery
5020 Steam Equipment and Machinery
5021 Steam engines, settings, grates, boilers, stokers, condensers, heaters, feed pumps, ash and coal handling equipment
5030 Gas and combustion machinery
5031 Automobiles, trucks, and trailers
5032 Engines and accessories
5033 Boats, motor boats, and aeroplanes
5040 Hydraulic machinery
5050 General machinery
5051 Shop machinery including lathes, planers, sharpeners, drilling and boring machines, grinding machines, punches, presses and forges
5052 Grounds keeping machinery
5053 Mowers
5054 Printing machinery
5055 Scales—warehouse and platform
5060 Fire apparatus and equipment
5070 Hand tools, including benches, vises, ladders, hand trucks
5080 Sanitary Equipment—vacuum cleaners, drinking fountains, wash stands, sinks, etc.
5090 Unclassified machinery and tools

6000 MUSEUM SPECIMENS

7000 ATHLETIC EQUIPMENT

7001 Bleachers
7010 Playground Equipment
7011 Play apparatus (indoor)

PART III

Applications in the University Business Office

CHAPTER II

University of Minnesota

By
W. T. MIDDLEBROOK
Comptroller

THE University of Minnesota has been using tabulating machines in the Accounting Department since 1926. At present the equipment consists of a type 4 direct subtraction tabulator with summary punch, a sorter, an interpreter, an automatic duplicating key punch and an automatic verifier. The method of attaining the desired reports has varied considerably during these eight years. The procedure now in use is a result of that evolution, and is performing the accounting work more satisfactorily than could be done by any other method.

The accounts are kept on a cash basis. By that is meant that income is not recorded as such until the cash is received, nor are expenditures recorded until the cash is disbursed. There is an exception to this in accounts receivable, but the amount collected through this account represents only a small portion of the University income. Invoices are paid during the month immediately upon their approval by the proper authorities.

The classification of accounts as recommended by the National Committee on Standard Reports for Institutions of Higher Learning has been adopted in principle.

As recommended, there are four major groups of funds:

1. Current funds
2. Loan funds
3. Endowment funds
4. Plant extension

The accounts are designated by an eight digit code number. This code number is divided into two parts, each of four digits. The first is known as the department number; the second, as the budget number. The department number is essentially a general ledger account number. The budget number is a subdivision of the department number, showing the nature of the account and the fund from which the expenditures are made. For example, budget No. 1100 would show that the account is a salary budget paid out of the Support fund while 1200 would be a salary budget paid from the Adams fund, and 2100 is a supply budget paid from the Support fund. The number in the thou-

sands position designates the nature of the account, while the last three digits designate the fund.

The University has about 160 trust funds or appropriations for which it must keep separate accounting records. This is accomplished by coding these funds and incorporating their code number in the budget number. In addition to the department and budget numbers, all items of income are further classified as to the source and nature of the income. The expense items are also further classified according to the object of the expenditure. The classification in use is again quite similar to that recommended by the National Committee on Standard Reports for Institutions of Higher Learning, though the system of coding is different.

The charges to the operating accounts or budgets are made on a commitment basis. The requisitions are charged to the departmental budget, as soon as they are approved, and credited to a Reserve for Open Requisitions. The invoices, when paid, are charged in the general ledger to this Reserve for Open Requisitions. This means that the balance in a departmental budget represents the amount remaining that may be requisitioned, and the balance in the Reserve for Open Requisitions represents the amount of cash that must be reserved to pay for the item requisitioned.

General Ledger and Budgetary Control

There are five groups of transactions which are recorded on tabulating cards and from which the general ledger postings are made. The first of these groups is the annual budget and those transfers of funds, which constitute changes in the annual budget. The code numbers are incorporated in the annual budget and the cards are punched directly from that document. The changes, as requested by departments, are submitted on a special form, known as the "Request for Transfer of Funds." When these have been approved, cards are punched from them.

The second group includes requisitions for the purchase of supplies and equipment and the payment of other services and expenses. In the same group are the authorizations, or job orders, as they are often known. They are the transactions through which the commitments, or obligations are set up.

The third group includes cash receipts. Cash receipts are not necessarily income, but may be credits to balance sheet accounts, or expense accounts.

The fourth group includes disbursements. Disbursements are not necessarily a charge to an expense budget, but may be debits to balance sheet accounts or to income accounts.

The fifth group includes all journal entries or inter-departmental transactions. They include distribution journal vouchers, bills between departments for exchange of supplies or for services rendered, the issues from the storehouses and the billing of closed authorizations or job orders.

For the sake of uniformity in procedure, requisitions are made for all cash disbursements, except the payments of salaries. In the case of expenditures, which are chargeable to balance sheet accounts, the requisition is merely a medium of securing the approval for the transaction. It is not charged to

the balance sheet account. The invoice, when paid, becomes the basis of the charge. On the operating budgets, the requisition is charged to the budget and credited to the Reserve for Open Requisitions. When the invoice is paid, the requisition number against which it applies is recorded on the card as well as the invoice and the account numbers to which the requisition was originally charged.

Each card carries a reference number and the original data from which the card is prepared are filed according to this reference number, permitting easy reference to the original record. The original records in the cash receipts and journal entries are carefully bound and constitute the registers of receipts and journal entries. The vouchers prepared in payment of the invoices have to be abstracted, before they are sent to the State Treasurer for payment. This record, with the file of invoices, serves as a register of payments. It has not been necessary to prepare from the cards any registers in addition to these mentioned.

All of the above entries are recorded on the same form of tabulating card. (Fig. 89). This card has fields for the recording of the following information:

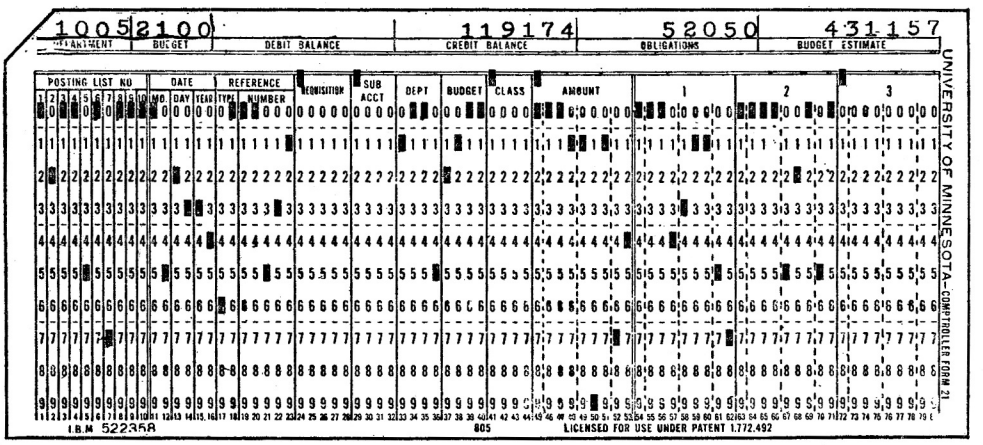


FIG. 89

1. Posting list number
2. Date
3. Type of entry
4. Reference number
5. Requisition number
6. Sub-account number
7. Department number
8. Budget number
9. Classification number
10. Amount

In order to record in addition to the budget balance, the amount of the allotment and total of the commitments, it was found necessary to use several amount fields which are designated by the numbers 1, 2 and 3.

When the cards have been punched and verified, they are sorted into order by funds within each of the four major fund groups. Since the cards punched for transfers of funds and for requisitions are always in balance by fund, they will not affect the totals by fund to be secured by tabulating the cards. It is obvious that journal entries will occur between accounts of different funds.

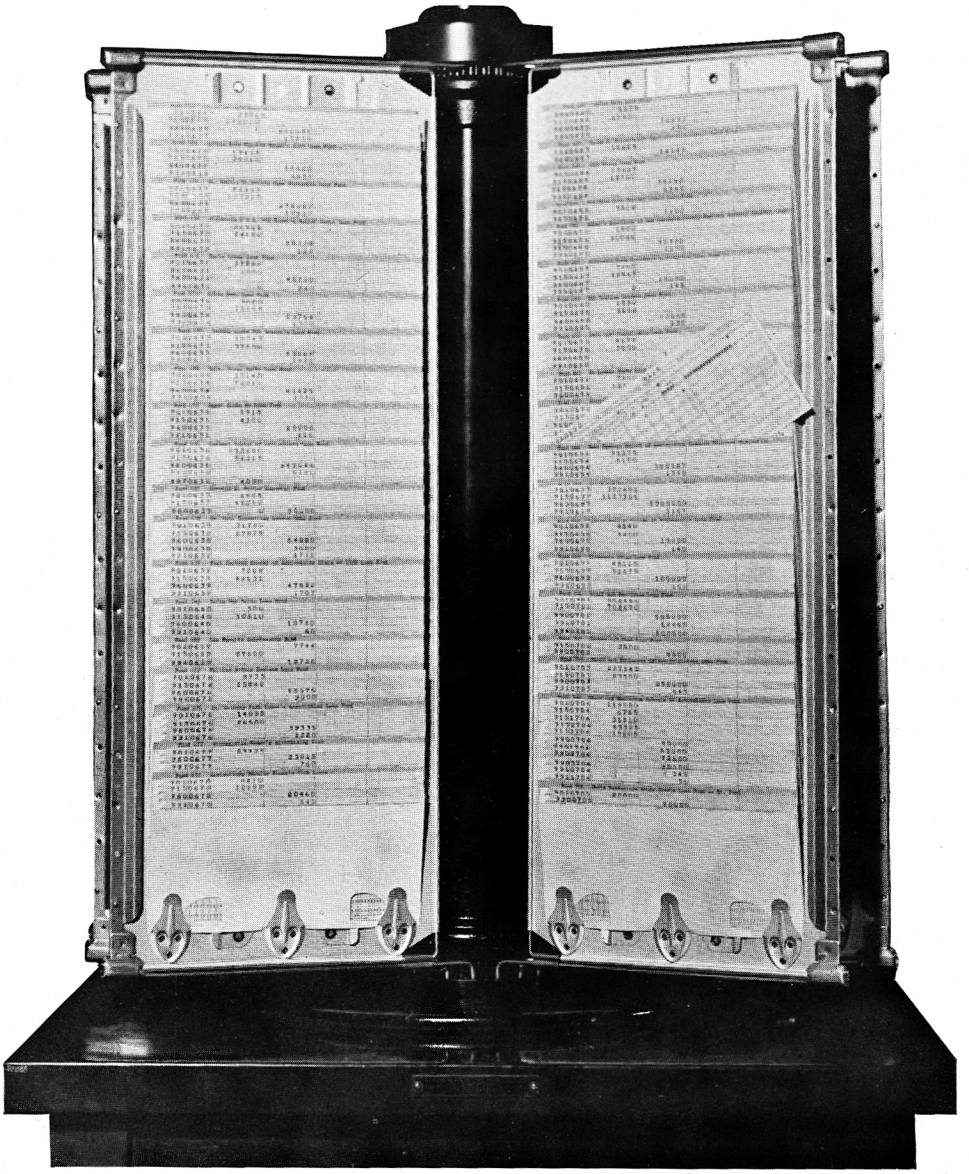


FIG. 90

Special Balance Card Rack

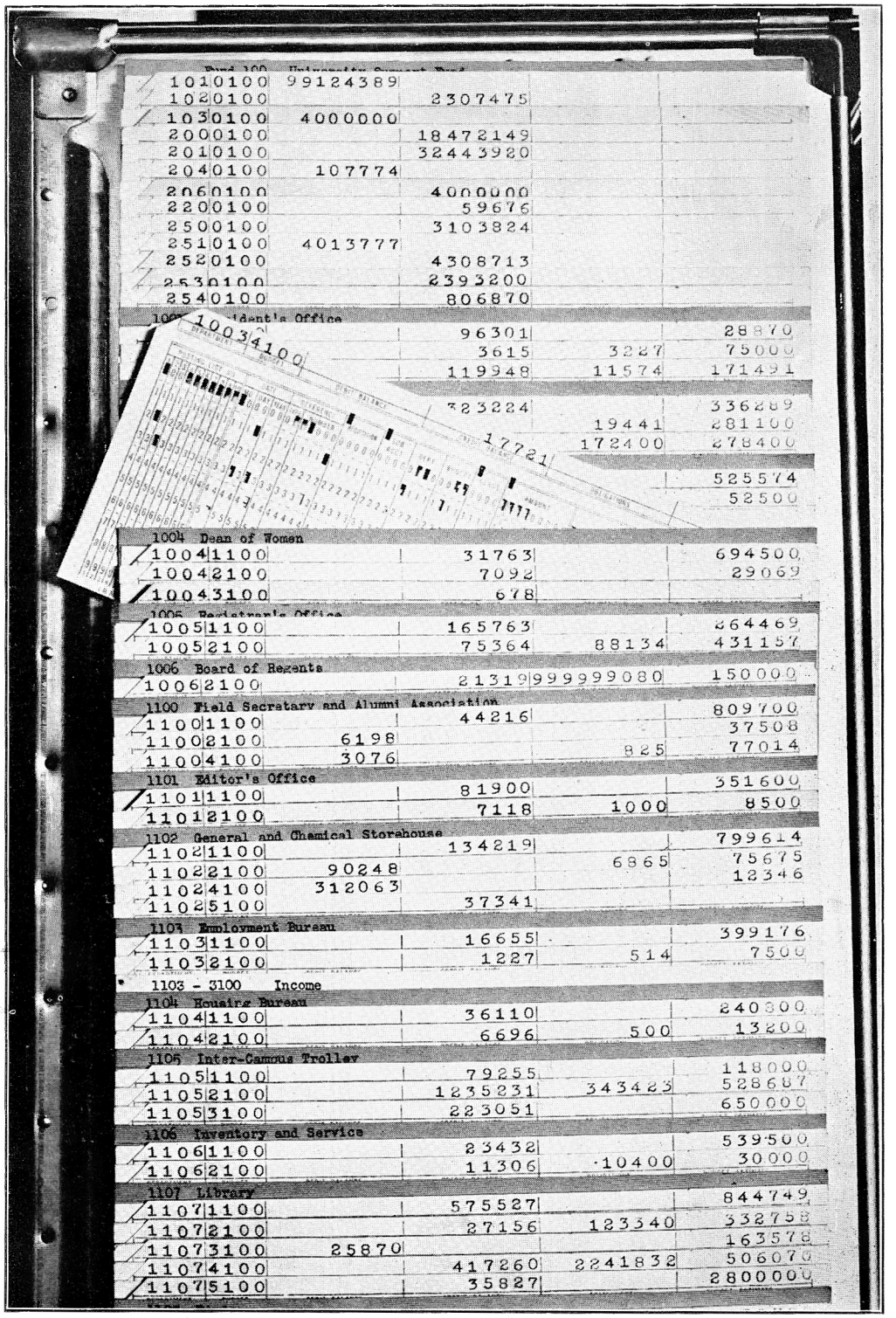


FIG. 91—A Leaf of the Balance Card Rack

It is therefore necessary to set up a "Receivable or Payable between Funds" account in each of these funds to accumulate the resulting adjustments. Similarly, a voucher drawn on the support fund may include the payment of invoices which are chargeable to other funds. A tabulation is made to determine the amount of the adjustments, which must be made to reflect these facts. Cards are then punched for these adjustments and inserted manually with the other cards in the posting list after they have been sorted by department and budget number. This insures a constant balance of the accounts within each fund. After the cards for a particular posting list have been completely sorted and are ready for tabulation, they are needled and a balance card is selected from a rack (Fig. 90) and inserted manually before these cards are tabulated. A summary punch produces a new balance card, which shows the up-to-date budget allotment, the commitments and the free balance. As these cards are removed from the summary punch, they are placed in the interpreter, which prints on the top line of the card the amounts just mentioned. These cards are then returned to the rack and filed in such a way that only the account numbers and the interpreted amounts are visible (Fig. 90).

The information on account balances is in this way kept constantly up to date and does away with the necessity of using any posting machines to accumulate the balances. The detailed information concerning the charges is listed by the tabulating machine at the same time that the summary card is prepared and is available during the month for reference to the detailed transactions.

The summary cards produced in tabulating the daily postings to the general ledger make a convenient record of the account balances. By filing these cards, as illustrated (Fig. 91), not only the balance, but the up to date allotment and commitment figure is visible. This file serves several purposes. When the cards are pulled, any errors in coding are usually caught, inasmuch as there will be no card in the file for the account. If the wrong card should be pulled, a separate summary card will be made for the balance card that was pulled in error and another one for the amount that should have been posted to the proper account. When these are returned to the file, the card that was pulled in error goes back in its proper place and the account for which no balance card was pulled will be filed with the balance card that is in the file. The cards are refiled by the accountant, which enables him to review every account that has been active and yet requires comparatively little of his time. The same procedure is applied to jobs in process, except that in place of showing the free balance, the cash balance on the job is recorded. From this file of cards statements of the accounts for any or all funds can be made during the month with little effort.

At the close of the month, all of the cards which were posted during the past month are brought together and sorted into department and budget order, together with last month's trial balance. From this is tabulated the official general ledger (Fig. 92). The posting lists could be used for this purpose, but the information is more condensed and usable when the lists are summarized once a month.

GENERAL LEDGER

University of Minnesota

Dept.	Bud.	Sub-Account	Reference	Type	Debit	Credit
1001	1100		430	01		3232 63
		6	1166	02		246 00
			515	34	838 54	
			530	34	838 54	
1001	1100					1801 55
1001	2100		430	01		78 31
			8490	07		1 25
			8492	07		6 00
			8610	07		50
			49176	06	3 50	
			7771	11	2 75	
			8157	11	21 78	
			5766	12	3 41	
			6419	12	60	
			6554	12	45	
1001	2100					53 57
1001	4100		430	01		1346 34
			7686	11	31 12	
1001	4100					1315 22
1002	1100		430	01		9626 02
		37	962	02		550 00
		19	1070	02	600 00	
		26	1070	02	640 00	
		33	1070	02	59 03	
		37	1070	02		1299 03
		37	1113	02	18 97	
		38	1133	02		435 00

FIG. 92

When this monthly general ledger is tabulated, cards are summary punched. These constitute a new trial balance of all the accounts of the University. After the general ledger has been tabulated, the operating accounts, or budgets, as they are commonly known, are listed a second time. This time, they are printed on fan-fold forms and separated. Each department receives, in this way, a statement of its account during the past month. The jobs in process are summarized in similar fashion. The jobs in process summary cards constitute a trial balance, the totals of which must check with the control in the general ledger.

Expenditure and Income Distribution

After the cards have been used to prepare the general ledger, all cards covering allotments, transfers of funds, requisitions and authorizations and all charges to balance sheet accounts regardless of type of entry are sorted out. The remaining cards are then separated by the classification numbers into income and expense groups.

To these groups of cards are added the summary cards from last month's expenditure and income tabulations. They are sorted by classification, budget and department and listed. Totals are taken for each department and budget. (Fig. 93). From this record, it is easy to obtain the totals for any classification since the account will show the total of that particular classification for the previous month and the detail transactions during the current month. The treatment of income items is identical to the one used for expense items.

DISTRIBUTION OF EXPENDITURES

University of Minnesota

Dept.	Bud.	Class	Reference	Type	Debit	Credit
1001	1100	1900	430	30	16810 07	
1001	1100	1900	515	34	838 54	
1001	1100	1900	530	34	838 54	
					18487 15	
1001	2100	2000	430	10	245 77	
1001	2100	2000	7771	11	2 75	
1001	2100	2000	5766	12	3 41	
1001	2100	2000	6419	12	60	
1001	2100	2000	6554	12	45	
1001	2100	2000	9086	16	9 75	
1001	2100	2000	9087	16	30 00	
1001	2100	2000	9088	16	3 50	
1001	2100	2000	430	30	40 92	
1001	2100	2090	430	10	10	
1001	2100	2090	430	30	550	
1001	2100	2200	430	10	400	
1001	2100	2210	430	10	212 80	
1001	2100	2210	8157	11	21 78	
1001	2100	2400	430	10	26 51	
1001	2100	2700	430	10	200	
1001	2100	2990	430	30	1600	
1001	2100	3020	430	10	27 12	
1001	2100	3020	430	30	183 50	
					836 46	
1001	4100	1400	430	30	128 0	
1001	4100	2000	430	10	60 20	
1001	4100	2210	430	10	30 09	
1001	4100	2990	7686	11	31 12	
1001	4100	2990	430	30	265 48	
					399 69	

FIG. 93

Summary cards are not procured in this tabulation, since it is desirable to secure totals only by department and budget and to keep the report as condensed as possible. Therefore, a second tabulation is made of these same cards, where totals are taken, not only by department and budget, but by detail classification and the three major groups of cards included, namely cash receipts, invoices and journal entries.

The reason for breaking these classifications down by the three major groups of entries is to satisfy the State Examiners, who require an analysis of these three groups by detail classification. It is almost unnecessary to point out that from these summary cards, statements by fund, by department, by budget, by classification, or by any combination of these classifications, can be secured.

Allotments and Transfers of Funds

Each month transfers are listed to show every change that has been made in the allotments for each account since the beginning of the fiscal year. Cards are summary punched for these totals.

Obligations

Each month, after the foregoing reports have been tabulated, the cards representing the open requisitions and any invoices against these open requisitions at the close of the previous month, together with the requisitions and invoices of the current month are tabulated by requisition number and budget number. Every requisition that is closed should balance, which is indicated by the absence of any totals for those items (See Fig. 94).

OBLIGATIONS - BY REQUISITION NUMBER

University of Minnesota

Requisition No.	Dept.	Bud.	Debit	Credit	Total by Fund
8388	1002	2100			
8389	2204	2100			
8390	3200	2100			
8391	3000	2100			
8392	4001	4100			
8393	2220	2100			
8396	2204	2100		350 00	
8397	2400	2100			
8398	2601	2100			

FIG. 94

By controlling on the account numbers, as well as requisition numbers, any errors in coding or calculations will be revealed. The cards representing the closed requisitions are pulled and filed in the "closed file." The remaining cards are re-sorted by department and budget and listed to show in detail all transactions affecting the open requisition (Fig. 95). Totals are secured by department and budget. Summary cards are punched for each total. This

STATEMENT OF OBLIGATIONS

University of Minnesota

Dept.	Bud.	Requisition No.	Reference	Type	Debit	Credit
		47368	47368	06		11 06
		47426	47426	06		5 00
		47602	47602	06		4 00
		47603	47603	06		9 00
		48018	48018	06		9 00
		5503		8		37 00
		5679	5679	08		27 50
		5727	5727	08		83 38
		9244		8		200 00
		9244	9244	08		100 00
2220	2100					771 15
		30374		6		48 10
2221	2100	30374	7145	32	2 40	3 00
		44911	44991	06		
		44991	44991	07	98	
		44991	19290	32	2 02	
		45127	45127	06		6 00
		45379	45379	06		2 55

FIG. 95

statement makes an excellent analysis of the *Reserve for Open Requisitions.* The authorizations and the bills for completed authorizations are treated in the same fashion and a statement of open authorizations is prepared.

Capital Expenditures

Each month a statement is prepared showing all items of capital expenditure. From this report, the inventory clerk prepares inventory cards against which he will ultimately check the actual equipment.

Monthly Budget Reports

When the summary cards showing the free balances in the budgets, the summary cards for expenditures and income, the summary cards for obligations, are added to the original allotment cards and sorted by department and budget number, a statement is made showing for each budget the amount of the original allotment, the increase or decrease in that allotment, what miscellaneous income may have been credited to it, what the total of expenditures is, what the total of commitments is, and the free balance. (Fig. 96.) All this is printed on a single line for each account, a separate column being provided for each class of information.

MONTHLY BUDGET ANALYSIS

University of Minnesota

Dept.	Bud.	Budget	Transfers of Funds	Income	Expenditures	Increase in Obligations	Free Balance
2002	2100	87 00	51057		28720	00002937 6	1661
2003	1100	45888 00	999444819		3563967		669652
2003	2100	1750 00	161025		437406	99997321 4	99999254 03
2006	1100	87076 00	31000		7436784		1301816
2006	1207	2625 00			218760		43740
2006	2100	1225 00	47500		124443	00002586 9	19684
2007	1100	5481 00	999990488		274573		84015
2007	2100	350 00	12500		47595	9999797 00	20205
2008	1100	11796 00			1007016		172584
2008	2100	350 00	49315		112913	9999806 97	99999870 05
2009	1100	29445 00	4000		2561215		387285
2009	2100	1485 00	166368		104252	00011046 8	100148
2010	1100	129000					129000
2010	2100	5000 00	999999845		432197	9999985 63	89085
2011	1100	26332 00	181978		2435202		379978

FIG. 96

This report condenses and analyzes the budget activities so as to furnish a control not possible under any other plan.

A similar statement is made for the income accounts, showing the original estimate of income, the changes in that estimate of income, the income received, the refunds that have been ordered, but not paid, and the amount of income over or under the estimate.

In addition to the tabulations described numerous other reports and analyses are prepared. Some of these are prepared periodically and others are prepared to answer some special problem for the Administration, the State Examiners or the State Legislature.

There is in preparation a procedure for investment control. This involves the punching of cards for each investment. From these cards will be tabulated statements of the investment portfolio for each fund, statements of the total amount of each security subdivided by funds, and statements of income from investments.

A tabulating machine method of storehouse inventory control is also contemplated.

Another application of the tabulating method which is being studied is the preparation of the semi-monthly payroll. With the use of alphabetic equipment and the checkwriting interpreter it will be possible to prepare the payroll and the pay checks with a minimum of expense and time.

PART III

Applications in the University Business Office

CHAPTER III

New York University

By
EARLE L. WASHBURN
Auditor

WITH the thought that other institutions might be interested in the use we are making of tabulating machines in our bookkeeping departments, this description is offered, supplementing those of the other administrative departments which use the equipment.

In 1921-1922, when our budget amounted to about $2,000,000, it was becoming evident that bookkeeping by manual methods failed to provide us each month with information concerning our budget position promptly enough to aid in determining administrative policies and to permit rendering statements on condition of appropriations to the operating departments. After two years of investigation we installed, in 1924-1925, two bookkeeping machines which met the situation until the year 1929-1930, when our total budget had risen to $7,000,000.

After reviewing our methods again, we concluded to install the tabulating equipment we are now using, retaining the bookkeeping machines for use as outlined in the course of this article. The tabulating equipment is used jointly by three divisions of the administration and occasionally by some of the academic departments. The administrative departments using the equipment are: Auditor, Bursar, and Registrar.

The equipment consists of:

(a) One 45-column printing tabulator
(b) One sorter
(c) One gang punch
(d) One summary punch attached to tabulator
(e) Key, duplicator, and verifying punches in each office as required.

The cards are prepared under the supervision of the officer in charge of each administrative unit, the sorting and tabulating being done in a central office on a work schedule so arranged that there is no conflict among the departments using the joint equipment. The use by the Registrar and Bursar are described elsewhere, this article being confined to the Auditor's department.

The transactions of the Auditor are of two general types:

1) Those relating to the budget
2) Those relating to purchase and sale of investments and other capital funds.

Budgetary Control

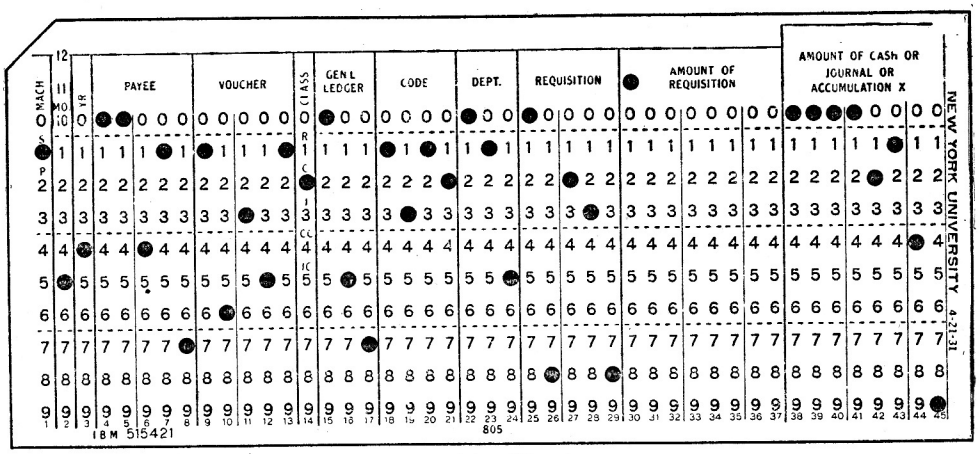


FIG. 97

These transactions call for the use of a card (Fig. 97) designed to provide information in detail concerning budget receipts and payments, and journal transfers of debits and credits between service departments and budget operating divisions. From these, statements to operating divisions may be prepared and simultaneously, divisional and consolidated aggregates determined by which the detail operations of all departments can be reduced to a limited number of basic figures. This permits a quick and accurate measure of our budget position after a few moments inspection.

By columns, the cards are used as follows:

1	To segregate the cards into two groups for posting to ledgers.
2 - 3	To identify cards by date.
4 - 8	To identify cards by payee so they can be traced to the voucher file of payees, maintained in alphabetical order.
9 - 13	Additional identification to determine specific item under each payee.
14	To segregate cards by the classes of cash, i.e., current or trust funds.
15 - 17	General ledger account.
18 - 21	Income and expense classification.
22 - 24	Operating departments to which detailed statements are sent (Fig. 98).
25 - 29	To record the identifying number on requisitions for which invoices have not yet been received, but for which there are outstanding purchase orders.
30 - 45	For amounts on requisitions, invoices, or journal entries.

NEW YORK UNIVERSITY
MONTHLY CONTROL BUDGET STATEMENT

School WASHINGTON SQUARE COLLEGE Department 18-PSYCHOLOGY Month JUNE 1, 1934

Description of Items	Code Number	Budget Current Month	Expenditures Current Month	Budget Year to Date	Expenditures to Date	Balance	Total Budget	Expenditures to Date	Outstanding Orders	Credits	Balance
LABORATORY FILING EQUIPMENT	1214			27.48	27.48			27.48			
DEPARTMENTAL TYPEWRITERS	1232			68.27	68.27			68.27			
ANIMALS	1301			1.50	1.50			1.50			
GRADES	1302			302.72	302.72			302.72	20.00		
DUPLICATING	1310	3.39	3.39	106.99	106.99			106.99			
ELECTRICAL SUPPLIES	1311			31.74	31.74			31.74			
EXPERIMENTAL MATERIALS	1312	142.57	142.57	310.57	310.57			310.57	48.92		
LABORATORY HARDWARE	1329			5.00	5.00			5.00			
LABORATORY LUMBER	1330			.93	.93			.93			
MODELS-SPECIMENS	1336			50.30	50.30			50.30			
PHOTOGRAPHIC SUPPLIES	1342			7.64	7.64			7.64			
REPAIRS TO APPARATUS	1348	63.10	63.10	290.38	290.38			290.38	1.00		
SLIDES	1366			23.33	23.33			23.33			
CARFARE	1378			2.24	2.24			2.24			
INSURANCE	1376			70.00	70.00			70.00			
MISCELLANEOUS	1399	904.60	904.60	945.26	945.26			945.26			
OTHER SUPPLIES							2888.65	0	0	122.5	$888.02

FIG. 98

Cards for receipts are tabulated separately from those for payments. Deposit statements are prepared each day by the clerk in charge of deposits and a number given to the deposit statement. This number is punched in columns 9 – 13.

Attention is called to the description "Accumulation" above columns 38 – 45. On our statements to the departments we are required to show the expenditures for the year to date (See Fig. 98), as well as for the current month. By use of the x position and a summary punch we automatically obtain cards for the "year to date" figure while the tabulation for the current month is being prepared. In tabulating for the detail statements to the departments the paid invoices and requisitions are combined and all figures in the code columns are used, resulting in a tabulation (Fig. 99) from which Exhibit Fig. 98 is struck

NEW YORK UNIVERSITY
TABULATION SHEET
FOR
CONTROL BUDGET STATEMENT

	ACCOUNT NUMBER	DEPARTMENT NUMBER	CLASSIFICATION NUMBER	EXPENDITURES CURRENT MONTH	EXPENDITURES YEAR TO DATE	REQUISITIONS
	57	16	1303		2053	60
	57	16	1307			2000
	57	16	1310		1942	
	57	16	1312		9900	
	57	16	1358		200	
	57	16	1399	860	1956	
				860	16051	2060
	57	23	1227		47500	
	57	23	1347		2500	
					50000	
	57	24	1310		78	
	57	24	1348	213	1237	
				213	1315	
	57	25	1303		7500	
	57	25	1305		1631	
	57	25	1307		7050	
	57	25	1310		1450	
	57	25	1311	300	765	
	57	25	1312		10575	
	57	25	1335		5100	
	57	25	1342		15337	
	57	25	1369		520	
	57	25	1373		138	
	57	25	1378		164	
	57	25	1399		20432	
				300	70662	

FIG. 99

off. Just preceding this a tabulation is made employing only the first two figures of the code number. This tabulation (Fig. 102) provides a posting summary of cash transactions, the totals of which are carried to bookkeeping machine cards which form the general ledger. The classification ledger and the department ledger are posted simultaneously with the divisional control ledger by superimposing the former on the latter (Fig. 100). From the classi-

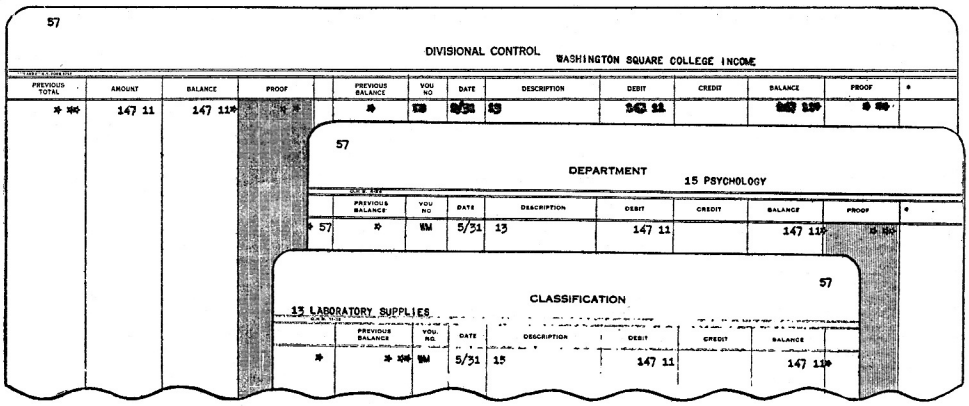


FIG. 100

fication ledger master cards (Fig. 101) are prepared, a tabulation of which re-

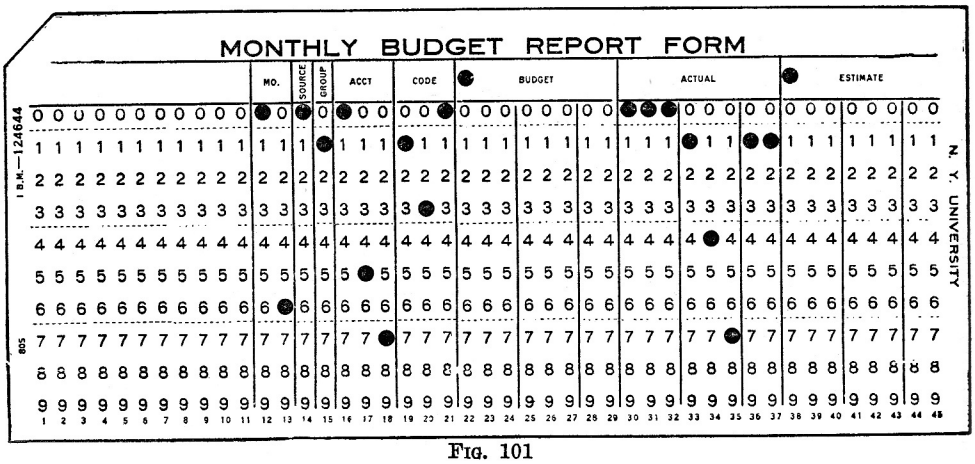


FIG. 101

sults in a consolidated statement (Fig. 103) for each division and for the entire institution. The "estimated" column in this Exhibit (Fig. 103) is prepared by the Auditor's office and is based upon requisitions and other factors not actually a matter of book record.

Investment Inventory and Control

These transactions call for a card of an entirely different character from those just discussed. They result in changes in the investment portfolio and we decided our primary interest lay rather in the portfolio itself, and the income

NEW YORK UNIVERSITY

O M B 10140

PAYEE	ACCOUNT NUMBER	CLASSIFICATION	DEPARTMENT	AMOUNT	TOTAL
1405	56	13	360	3982	
4053	56	13	360	350	5882
3151	57	18	000	73205	
4035	57	18	000	32	73237
284	57	24	000	1212	
440	57	24	000	3500	
1086	57	24	000	46390	
2101	57	24	000	900	
2107	57	24	000	6500	
2688	57	24	000	368	
2762	57	24	000	4500	
3119	57	24	000	1396	
3785	57	24	000	269	
3979	57	24	000	1750	
3985	57	24	000	4200	70985
1021	57	25	000	2500	2500
3179	57	29	000	540	540
3606	57	44	000	186277	186277
181	57	13	001	3332	
439	57	13	001	6088	
454	57	13	001	4414	
823	57	13	001	1125	
1218	57	13	001	7410	
1447	57	13	001	750	
2435	57	13	001	1930	
3031	57	13	001	89	
3094	57	13	001	14795	
3428	57	13	001	1600	
3609	57	13	001	556	
4040	57	13	001	1421	
4926	57	13	001	3151	
6324	57	13	001	13200	59861
454	57	13	002	10672	
650	57	13	002	745	
2435	57	13	002	2410	
3233	57	13	002	1413	
4302	57	13	002	6475	
6369	57	13	002	1875	23590
235	57	13	003	1221	
1148	57	13	003	3281	
3116	57	13	003	10000	
3456	57	13	003	460	14962
15	57	13	004	616	
187	57	13	004	2550	
202	57	13	004	165	
228	57	13	004	763	
454	57	13	004	309	
650	57	13	004	380	
803	57	13	004	202	
804	57	13	004	216	
864	57	13	004	300	
2435	57	13	004	693	
2986	57	13	004	696	
3017	57	13	004	775	
3267	57	13	004	2000	
4036	57	13	004	9419	
4044	57	13	004	2832	
4913	57	13	004	908	
6369	57	13	004	1500	24324
417	57	13	015	2149	
1218	57	13	015	1549	
2986	57	13	015	154	
3008	57	13	015	709	
3503	57	13	015	10150	14711
2716	57	13	016	860	860
240	57	13	025	300	300
4376	57	13	033	206	206
43	57	11	070	25	
353	57	11	070	353	
423	57	11	070	1801	
447	57	11	070	233	
1008	57	11	070	250	
1534	57	11	070	4039	
1627	57	11	070	100	
1851	57	11	070	1490	
2228	57	11	070	1542	
3052	57	11	070	11296	
3163	57	11	070	1397	
3468	57	11	070	21090	
3488	57	11	070	960	
3683	57	11	070	100	

FIG. 102

University College
Statement of Operations
July 1, 1933 to April 30, 1934

Income	Code #	Budget 1933-1934	Actual 1933-1934	Estimate 1933-1934	Estimated Total 1933-1934
Student fees	500	46764000	44460021	2718954	47178975
Endowment income	510	10732.0	8943.2	1788.77	10732.0
Dormitory rents	520	960000	786087	173913	960000
Athletic and non-athletic fees	550	2433025	2433025		2433025
Outstanding fees	560			1530000	1530000
Total		51250235	48563516	4601744	53165260
Expense					
A - Instruction					
Salaries for instruction	100	30524000	25336403	5177595	30513998
Laboratory supplies and equipment	130	2695945	2273938	422007	2695945
Supplies other than laboratory	140	62500	43819	18681	62500
Laboratory labor	150	1374001	1139939	234062	1374001
Prizes and scholarships	160	80000	80000		80000
Other student aid	161		85500		85500
Athletic and non-athletic fees	191	2433025	1691475	741550	2433025
Total		37169471	31421074	6593895	38014959
C - Office					
Clerical payroll	200	794500	656145	138385	794500
Office equipment	210	9116	8835		8835
Office supplies	220	130986	106855	24131	130986
Bulletins and advertising	240	130000	112087		112087
Association membership	250	6071	5071		6071
Traveling expenses - prospective instructors	280	25000			
Total		1094673	888993	162486	1051479

FIG. 103

therefrom, than in the transactions by which the exchange was accomplished. As a trust company is custodian of our investments, principal cash rarely passes between us, all sums received from maturing investments being re-invested as quickly as possible.

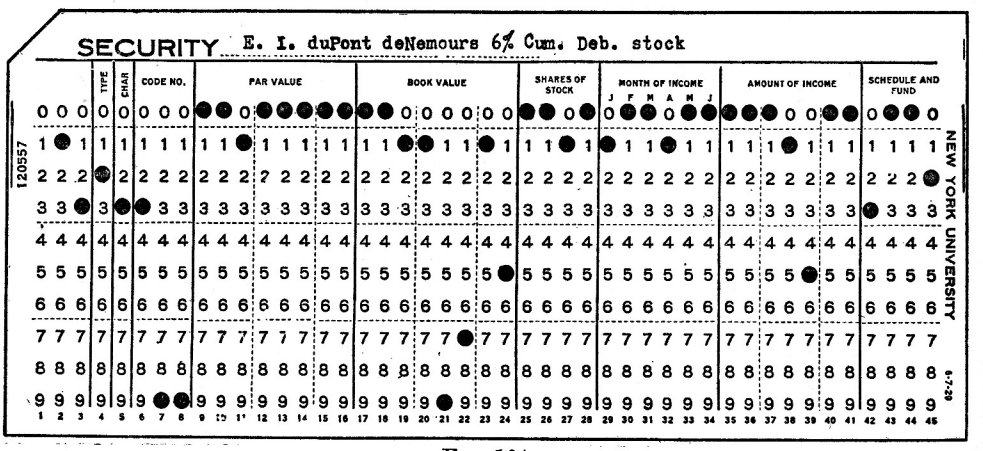


FIG. 104

A card (Fig. 104) was therefore designed to provide:

1) A code number for each security
2) A classification by
   (a) Type, i.e., bonds, stocks, mortgages, etc.
   (b) Character, i.e., Railroad, public utility, etc.

NEW YORK UNIVERSITY

TOTAL SECURITIES OWNED

FUND CODE No.	SECURITY CODE No.	NUMBER OF SHARES	PAR VALUE	BOOK VALUE
701	110		700000	707875
701	124		100000	99200
701	125		200000	140500
701	126		100000	94950
701	147		1300000	1278875
701	168		200000	184000
701	302	180	1800000	1440000
701	312	10	100000	100000
701	317	10		7550
701	319	31	310000	500000
701	3511	36		361800
701	352	11		109945
701	357	3	80000	113800
701	358	32	320000	491200
701	359	104	1040000	1251000
701	397	1	10000	11950
701	715			25870000
		423*	6260000*	32852945*
702	317	2		19990
702	340	271	2710000	2470848
		273*	2710000*	2510838*
703	104		1500000	1531125
703	157		2500000	2656250
703	162		100000	83250
703	172		100000	102375
703	180		500000	431250
703	210		645000	645000
703	211		1075000	1075000
703	225		376250	376250
703	250		860000	860000
703	251		860000	860000
703	252		817000	817000
703	253		322500	322500
703	254		1505000	1505000
703	259		63950	63950
703	3502	100	1000000	800000
703	3502	1505		2332750
703	3500	323		476425
703	3531	323	323000	1090125
703	3533	323	32300	125153
703	3535	204		331500
703	3541	570	1425000	833625
703	3543	468		1068650
703	3545	1585	1856000	5939200
703	3560	367	967500	1296450
703	3561	2258	2256000	7169150
703	3567	108	1080000	1139400
703	3563	1000	2500000	4025000
703	500		483750	483750
		9225*	60176250*	38440138*
705	145		800000	710000
705	317	5		49975
705	3561	1		10050
705	3567	222		219042
705	3577	32	220000	312950
705	361	200		918000
		450*	1020000*	4191015*
707	126		500000	476000
707	132		500000	491625
		*	1000000*	967625*
710	101		135000	135000
710	147		300000	295500
710	301	46	460000	460000
710	357	38	380000	540550
		84*	1275000*	1431050*

FIG. 105

NEW YORK UNIVERSITY

TOTAL SECURITIES OWNED

SECURITY CODE No.	FUND CODE No.	NUMBER OF SHARES	PAR VALUE	BOOK VALUE
119	2000		300000	300000
		*	300000*	300000*
120	2000		2500000	2117750
120	4000		2500000	2183750
		*	5000000*	4301500*
121	2000		5000000	5075725
		*	5000000*	5075725*
122	4000		3200000	3093000
		*	3200000*	3093000*
123	2000		5000000	5001125
123	4000		2500000	2425000
		*	7500000*	7426125*
124	701		100000	99200
124	2000		400000	423360
124	3101		4400000	4364800
124	3301		100000	99200
		*	5000000*	4987160*
125	701		200000	140500
125	715		600000	411500
125	3002		200000	140500
125	3003		1000000	700000
125	4000		500000	351250
		*	2500000*	1743750*
126	701		100000	94950
126	707		500000	476000
126	2000		6900000	6662300
126	3001		100000	95200
126	3003		400000	380800
126	3101		2000000	1904000
		*	10000000*	9613250*
128	2000		6500000	6461500
		*	6500000*	6461500*
129	1000		150000	33000
129	2000		5100000	5077687
		*	5250000*	5110687*
130	4000		5000000	4450000
		*	5000000*	4450000*
131	4000		5000000	3749125
		*	5000000*	3749125*
132	707		500000	491625
132	2000		500000	487492
132	3101		4000000	3898278
		*	5000000*	4877395*

FIG. 106

3) Par value of bonds or stocks
4) Number of shares
5) Book value (cost)
6) Month in which income is due
7) Amount of periodical income
8) Fund for which the security constitutes the investment.

An index file of code numbers, arranged both numerically and alphabetically, is, of course, maintained to identify the cards and a copy supplied to the officers of the trust company which handles our account.

To ascertain the investments of a single fund the cards are sorted on columns 42 – 45 and tabulated by code number to show par value and book value of bonds and shares of stock. Such a tabulation is set forth in Fig. 105. This total book value of the investments plus cash awaiting investment provides us at once with a figure to prove against the fund itself which is the sum for which the institution is accountable. By reversing the order of the tabulation we obtain a statement of the total amount of each security by code number sub-divided by funds (Fig. 106).

Code	Fund	Amount of Income
102	4000	22500
		22500*
108	4000	67500
		67500*
109	701	30000
109	2000	215000
109	3101	12500
109	3401	2500
		260000*
118	2000	150000
118	3601	3000
		153000*
121	2000	137500
		137500*
126	701	2500
126	707	12500
126	1701	62500
126	2000	172500
126	3001	2500
126	3003	10000
126	3101	50000
		312500*
159	2000	50000
		50000*
160	2000	18000
		18000*
161	2000	4500
		4500*

Fig. 107

Fund	Code	Amount of Income
701	109	30000
701	126	2500
701	312	
701	319	
701	351	5400
701	360	17500
		55400*
702	320	45
702	340	
		45*
705	351	150
705	356	
		150*
707	126	12500
707	320	375
		12875*
710	301	
710	320	135
		135*
711	320	135
711	351	600
		735*
1701	126	62500
1701	301	
1701	351	15750
1701	356	
		78250*

Fig. 108

When a change in the portfolio occurs, the cards representing the securities sold are removed from the file and replaced with new ones for those purchased. All transactions in securities and funds are booked by journal entries which are immediately posted to the ledger cards (Fig. 100), the tabulating cards (Fig. 97) being prepared subsequently and tabulated for purposes of proof only.

Just before the end of each month we wish to know the dividends and interest due during the following month. To secure this information we sort on columns 29 – 34, as follows:

29 for January and July
30 for February and August
31 for March and September
32 for April and October
33 for May and November
34 for June and December

NEW YORK UNIVERSITY

SUMMARY STATEMENT OF SECURITIES BY TYPES AND CHARACTERS

April 30, 1934

		% of Each Type to Total Book Value	Book Value	% of Each Type to Total Income	Income
BONDS	(Distribution by character in Group I below)	35 17	3 533 700 50	49 16	158 601 00
MORTGAGES		10 52	1 057 161 80	13 76	44 389 00
STOCKS (PREFERRED)	(Distribution by character in Group II below)	20 05	2 015 326 45	19 33	62 382 00
STOCKS (COMMON)	(Distribution by character in Group III below)	21 38	2 148 841 85	12 78	41 223 00
REAL ESTATE		12 48	1 273 816 05	4 97	16 034 00
Total		100 00	10 048 846 65	100 00	322 629 00
BONDS - GROUP I					
Railroad		47 17	1 666 947 19	38 73	61 382 00
Public Utility		25 27	893 042 36	30 71	48 700 00
Industrial		24 32	859 375 95	24 68	42 322 00
State and Municipal		2 24	77 597 50	2 77	4 387 00
Investment Trust		25	9 000 00	28	450 00
Real Estate		58	20 500 00	78	1 230 00
Miscellaneous		21	7 287 50	04	130 00
Total Bonds		100 00	3 533 700 50	100 00	158 601 00
STOCKS (PREFERRED) - GROUP II					
Railroad		15 05	303 374 92		
Public Utility		34 43	693 644 71	41 66	25 990 00
Industrial		50 39	1 015 406 83	58 34	36 392 00
Investment Trust		13	2 700 00		
Total Stocks (Preferred)		100 00	2 015 326 45	100 00	62 382 00
STOCKS (COMMON) - GROUP III					
Railroad		14 28	309 814 73	1 43	600 00
Public Utility		15 92	345 275 00	38 33	15 800 00
Industrial		63 23	1 371 241 93	51 08	21 468 00
Investment Trust		07	1 414 71		
Bank and Insurance		5 52	119 673 68	8 14	3 355 00
Miscellaneous		99	21 421 80		
Total Stocks (Common)		100 00	2 148 841 85	100 00	41 223 00
DISTRIBUTION OF INVESTMENTS BY CHARACTER					
Railroad Bonds		16 59	1 666 947 19	19 03	61 382 00
Public Utility Bonds		8 89	893 042 36	15 09	48 700 00
Industrial Bonds		8 55	859 375 95	13 11	42 322 00
State and Municipal Bonds		79	77 597 50	1 36	4 387 00
Investment Trust Bonds		09	9 000 00	14	450 00
Real Estate Bonds		20	20 500 00	80	1 230 00
Miscellaneous Bonds		07	7 287 50	04	130 00
Railroad Preferred Stocks		3 02	303 374 92		
Public Utility Preferred Stocks		6 90	693 644 71	8 06	25 990 00
Industrial Preferred Stocks		10 10	1 015 406 82	11 28	36 392 00
Investment Trust Preferred Stocks		03	2 700 00		
Railroad Common Stocks		3 08	309 814 73	19	600 00
Public Utility Common Stocks		3 44	340 275 00	6 90	15 800 00
Industrial Common Stocks		13 65	1 371 241 93	6 65	21 468 00
Investment Trust Common Stocks		02	1 414 71		
Bank and Insurance Common Stocks		1 19	119 673 68	1 04	3 355 00
Miscellaneous Common Stocks		21	21 421 80		
Real Estate Mortgages		10 52	1 057 161 80	13 76	44 389 00
Real Estate		12 48	1 273 816 05	4 97	16 034 00
Total		100 00	10 048 846 65	100 00	322 629 00

NEW YORK UNIVERSITY

CLASSIFIED LIST OF TOTAL SECURITIES OWNED

April 30, 1934

Title of Security	Quotations Cost	Quotations Market	Number of Shares	Par Value	Book Value	Market Value	Annual Income
BONDS							
RAILROAD							
Allegheny Corporation Collateral Convertible 5% (1950)	98½	44		87 000 00	85 677 50	38 280 00	4 350 00
Atlantic Coast Line Railroad Company General, Series "A", 4½% (1964)	75	91		30 000 00	37 491 25	45 500 00	2 250 00
Atlantic Coast Line Railroad Company (Louisville & Nashville) Collateral 4% (1952)	68½	84		30 000 00	20 526 25	25 200 00	1 200 00
Baltimore & Ohio Railroad Company Refunding, Series "D", 5% (2000)	100⅝	82½		59 000 00	59 500 32	48 675 00	2 950 00
Baltimore & Ohio Railroad Company 1st 5% (1948)	89	106½		50 000 00	44 500 00	53 125 00	2 500 00
Boston & Maine Railroad Company 1st, Series "AC", 5% (1967)	72	87		50 000 00	35 965 00	43 500 00	2 500 00
Canadian Pacific Railway Company 10-year Convertible Collateral Trust 6% (1942)	96	118		25 000 00	24 025 00	29 750 00	1 500 00
Central of Georgia Railway Refunding & General 5½% (1959)	101½	22⅝		16 000 00	16 255 20	3 640 00	880 00
Central Pacific Railway Company 1st Refunding 4% (1949)	79½	94		50 000 00	39 880 00	47 000 00	2 000 00
Chicago & Northwestern Railway Company General 4% (1987)	69½	75½		25 000 00	17 437 50	18 875 00	1 000 00
Chicago & Northwestern Railway Company 20-year 4½% (1949)	90⅝	48		50 000 00	45 375 00	24 000 00	2 375 00
Chicago, Milwaukee & St. Paul Railway Company General, Series "F", 4½% (1989)	76½	82		25 000 00	19 172 50	20 500 00	1 187 50
Chicago, Rock Island & Pacific Railway Company General 4% (1988)	75½	73½		25 000 00	18 812 50	18 125 00	1 000 00
Chicago Union Station Company 5% (1964)	101½	107		50 000 00	50 428 00	53 500 00	2 450 00
Cleveland, [illegible] & St. Louis Railway [illegible] Series "B", 4½% (19[illegible]	78				89 625 00	39 [illegible]	2 250 00
Colo[illegible] [illegible] Refu[illegible]					[illegible] 50		00

FIG. 109

Assume we wish to find the income falling due in January, we sort on column 29. All cards thus selected are then tabulated by code number subdivided into funds (columns 42 – 45) as shown in Fig. 107. By reversing the

order of the tabulation we also obtain the income for January for each fund (Fig. 108). By adding together the results of twelve such tabulations we may easily obtain the estimated annual income for any fund.

On the first of each month we also wish to know the value of our portfolio as measured by the quotation at the close of the last day of the preceding month, with the portfolio subdivided into securities by classes. To obtain this information we first sort on columns 4 and 5. Column 4 determines the nature of the investment, whether bonds, or stocks, or mortgages. Column 5 subdivides column 4 into railroad, public utility, industrial, etc. By tabulating these cards, controlling on the code field, we obtain the par value, book value and number of shares for all pieces in the portfolio. With this information as a guide, typewritten statements are prepared (Fig. 109). Copies of these and of the tabulations (Figs. 107 and 108) are furnished each month to the custodian of our investments.

PART III

Applications in the University Business Office

CHAPTER IV

New York University
(Continued)

By
W. R. HENDERSHOT
Bursar

SUPPLEMENTING the descriptions of the use of the Hollerith Tabulating Machines in other administrative offices of New York University, a brief description of their application to the work in the Bursar's Office is given in the following:

The student's ledger card which is presented to this office at the time of payment of fees is turned over to a key punch clerk who punches a fee total card (see Fig. 110) for each student's account. This card provides space for

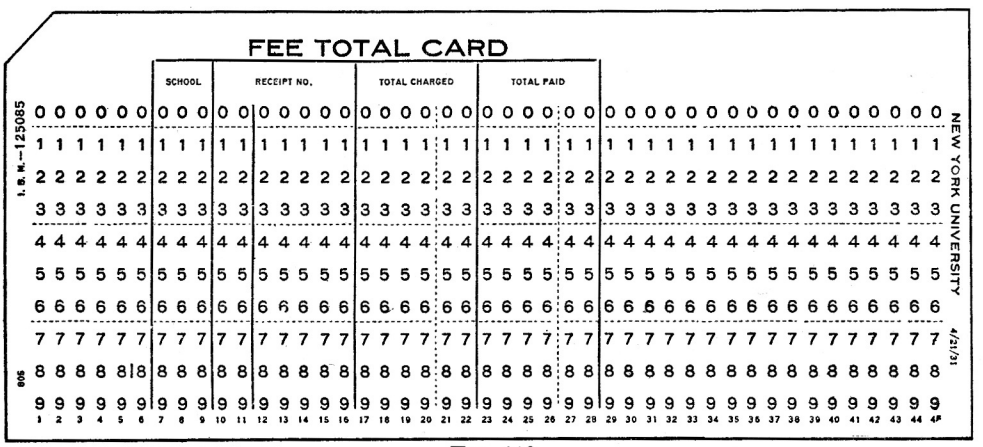


FIG. 110

indicating the school or college of the University in which the student is registered, designation of the cashier, the receipt number, the total amount of fees the student must pay for the term, and the amount he actually paid. These cards are tabulated numerically by receipt number and by schools for each cashier thus giving us our detailed daily cash receipt record (Fig. 111) as well as the total fees receivable in each school. The total collections tabulated for each cashier must agree with his daily receipts and are proved by a predetermined total obtained by adding machine listing the amount on each ledger card. While the University's books are kept on a cash basis and the accounts receivable are not recorded thereon, our fee total cards give us the information regarding our student accounts receivable necessary for budgetary control.

Cash Receipts and Student Fees Receivable

DATE June 11, 1934

School	Receipt Number	Name	Total Amount Receivable	Amount Paid
55	1 05695	George Allen	16200	16200
55	1 05696	Jane Doe	15600	10000
55	1 05697	John Smith	18900	900
			50700 *	27100 *
56	1 05692	Arthur Brown	17650	9650
56	1 05693	Paul Jones	19900	10000
56	1 05694	May Cooper	18650	1650
			56200 *	21300 *
57	1 05689	William Price	23300	23300
57	1 05690	James Hughes	17300	10000
57	1 05691	Henry Robb	14300	1300
			54900 *	34600 *
				83000 *
55			50700	27100
56			56200	21300
57			54900	34600
			161800 *	83000 *

FIG. 111

In addition to the fee for tuition we have over 300 different kinds of laboratory and incidental fees for which separate accounts must be kept. The keeping of these accounts is accomplished by punching on our fee distribution cards (see Fig. 112) the information appearing on the individual ledger cards. On the fee distribution card there is provision for indicating the kind of entry, the name of the school, the designation of the cashier, the receipt number, and the various kinds of fees. Special columns are provided for those fees which are charged uniformly to the majority of our students. Other columns allow us to indicate by code the various other fees that are charged only to students who

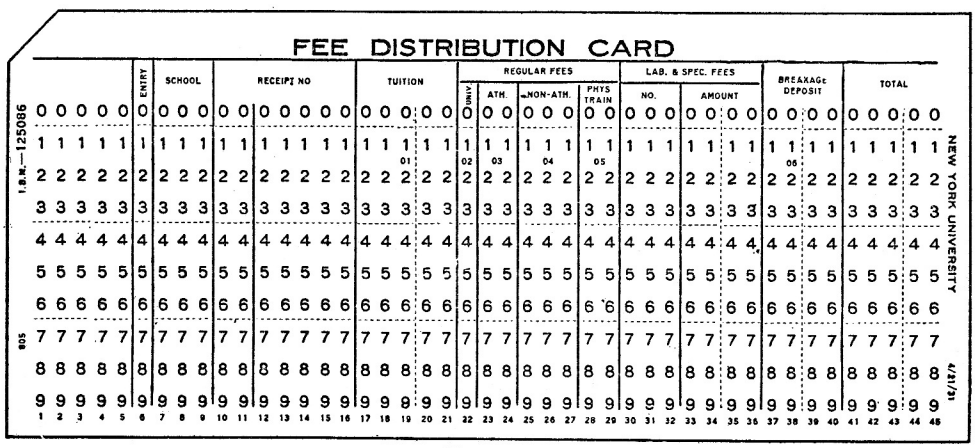


FIG. 112

enroll for the courses in which the fees are required. These cards are tabulated giving us our daily distribution of fee collections (see Fig. 113) by schools and kinds of fees rather than by cashiers and receipt numbers. The entry column on the fee distribution card is used to indicate the type of entry, that is, whether it is a cash collection, cash refund, or transfer to or from a school. All cash refunds and transfers are tabulated to show distribution of the fees refunded or transferred. The total daily distribution must, of course, agree with the total cash collections as indicated by the fee total card tabulation.

DISTRIBUTION OF STUDENT FEES

DATE_____

School	Fee	Amount	Totals by Schools	Total Amount
55	1	24400		
55	2	600		
55	4	1200		
55	11	500		
55	16	300		
55	43	100	27100	
56	1	16100		
56	2	600		
56	3	2100		
56	4	2250		
56	5	250	21300	
57	1	25700		
57	2	600		
57	3	2100		
57	4	1200		
57	6	1500		
57	10	1500		
57	11	1000		
57	12	1000	34600	
				83000

FIG. 113

In addition to the use of the machines for fee collection, they are also used in connection with our faculty payroll work.

The University is organized on a school basis and a great many of our faculty members teach in the same department in two or more schools. In these cases the monthly salary must be charged on a pro-rata basis or contract basis in accordance with the amount of teaching done in each school. One check is drawn to cover the full salary and a payroll tabulating card (see Fig. 114) is punched out covering the salary he receives in each department of each school so that we get a correct charge against the proper department each month.

The payroll tabulating cards also provide full information regarding a faculty member's status as to part-time or full-time, academic rank, school in which he is teaching, the department, classification (e.g., faculty, laboratory, clerical etc.), and his full monthly salary. Provision is also made for indicating

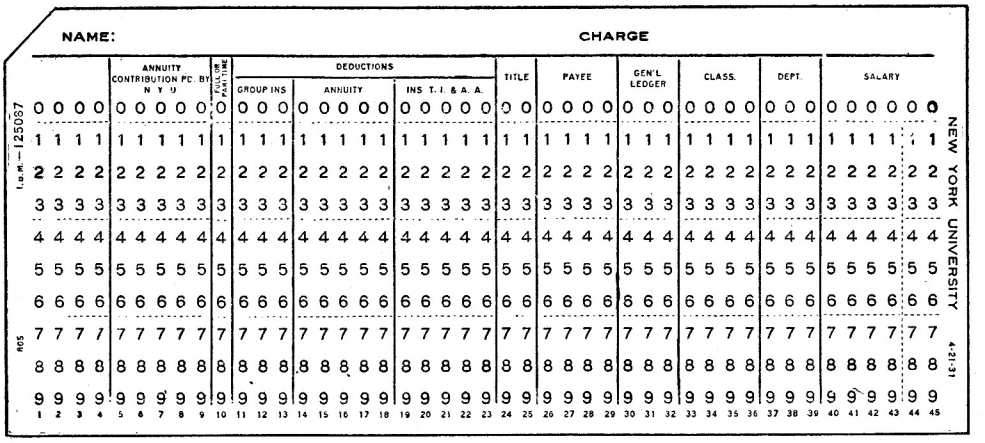


FIG. 114

Payroll card.

the deductions from his salary to cover group insurance premiums, contributions toward annuity policy, and deductions for life insurance carried with the Teachers Insurance and Annuity Association of America. His gross salary is indicated in the salary column and the amount of deductions in the deductions columns so that when the cards are tabulated we get the total charge against each school and department and a separate tabulation covering the deductions for various purposes. The total of the checks drawn to cover the payroll must be balanced with the total salary tabulation less the tabulation of deductions. This gives us an absolute check on our salaries and prevents the possibility of our paying a group insurance, annuity, or life insurance premium for an individual when the amount has not been deducted from his salary. Provision is also made for indicating the amount of annuity contributions paid by the University from which we get, together with the tabulation of the annuity salary deductions, the total amount of the monthly check which must be mailed to the Teachers Insurance and Annuity Association of America each month in payment of premiums due.

We know from experience that without the use of the Hollerith Machines it would not be possible for us to obtain the information we must have without greatly increasing our staff and even then the information would not be available until many weeks later than it is at the present time.

PART IV

Miscellaneous Administrative Applications

PART IV

Miscellaneous Administrative Applications

CHAPTER I

The University Press

By
HARVEY C. DAINES
Assistant Comptroller and Associate Professor of Accounting
The University of Chicago

TABULATING machines have been applied to a number of different tasks at The University of Chicago. The most important of these applications are the budget control procedure in the Comptroller's office and the job cost accounting in the Buildings and Grounds Department. For this article, however, another application is the subject. This application really represents a by-product installation at The University of Chicago. It is selected because it deals with a phase of administration not often encountered in universities and colleges, sales analysis.

The University of Chicago Press sells books all over the world, to a variety of customers. In addition to sales of books, it handles the distribution of various educational and scientific journals, the sale and rental of films, and materials sold as the result of radio programs.

To properly administer this type of business, it has been found desirable to keep inventories of books, to analyze sales, and to prepare certain journal entries for the accounting department. About a year ago certain parts of this work were assigned to the tabulating department.

Cards are punched for the sales of books and journals and for the sale and rental of films. In addition to these sales items, cards are punched for credit memos. The two cards are alike except for the red stripe on the "credit" cards.

Various fields are provided for recording the necessary information. (See

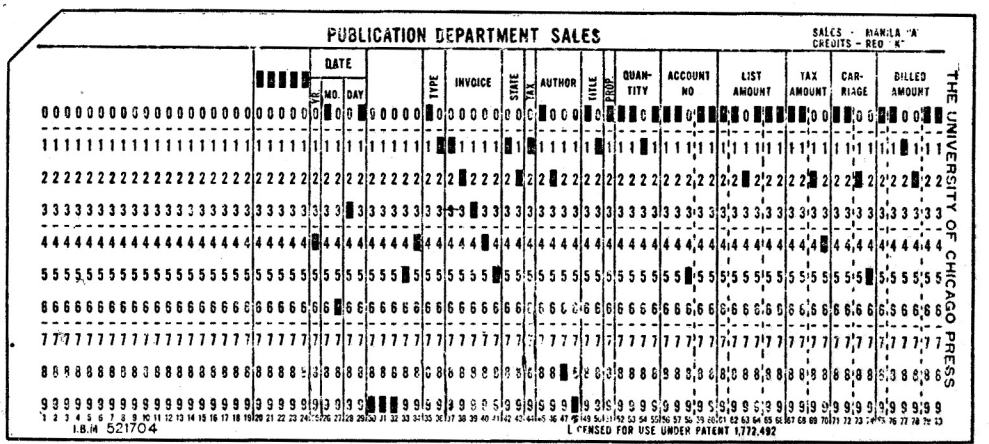


FIG. 115

Fig. 115.) Those for date, invoice number, state and quantity are self-explanatory. The others are:

DIFFERENCES: Where the amount received in cash differs from the amount billed, the difference is recorded in this field. A surplus is punched in positive figures and a shortage in complements.

TYPE: The left hand column of the two columns provided is used to record the kind of transaction; such as, cash sales, charge sales, cash refund or refund payable through "Accounts Payable." The other column shows whether the transaction is domestic, foreign, free, subject to examination, or on consignment.

TAX: Used to designate sales on which retail sales tax must be paid.

AUTHOR: A code is used which arranges the books in alphabetic order by the author's name.

TITLE: Each book by an author is numbered in sequence beginning with number one.

PROPERTY: Not used at present but will indicate the proportion of the University's ownership in the book.

ACCOUNT NUMBER: Designates the account to be credited or charged.

LIST AMOUNT: The amount of sale based on the catalog or list prices.

TAX AMOUNT: The amount of sales tax billed to the customer.

CARRIAGE: The amount of postage or other carrying charge billed to customer.

BILLED AMOUNT: The amount of sale after the discounts have been deducted but not including the amount of tax or carriage.

From the punched cards several reports are prepared. The first of these is prepared on the 10th and 20th of each month. It shows by book the net sales since the first of the month. This report is prepared in order that the sales department may have current information on those books which are selling and also to aid in determining when printings should be ordered.

The remaining reports are prepared at the close of the month. Of these the first is an "Allocation of Sales by States." It shows the total sales during the past month on a territorial basis at the list prices and the billed or net prices.

The second report is a "Monthly Report of Book Sales." (See Fig. 116.) It shows by book (Author and Title) the number of volumes sold for each of the following classes of sales:

1. Domestic sales
2. Foreign sales
4. Free or "on examination" shipments
6. Consignments

Since only the first two of these classes represent completed transactions, they are the only ones which will have amounts under list price and billed price. The last three columns of the report show the totals for each book. There are three columns: Quantity, List Price, and Billed Price. The monthly posting to the inventory control record is made from the total quantity column.

The next tabulation includes the same cards as the previous report. It itemizes for each book, the sales transactions during the month. In addition to the author and title it lists the invoice or reference number, and the quantity sold or returned. Totals are secured by book for sales and returns. Each month

MONTHLY REPORT OF BOOK SALES

THE UNIVERSITY OF CHICAGO PRESS

AUTHOR	TITLE	CLASS	QUANTITY	LIST PRICE	BILLED AMOUNT	TOTALS BY BOOK		
						QUANTITY	LIST PRICE	BILLED AMOUNT
10	02	1	8	3600	2587			
10	02	2	1	450	310			
10	02	4	6					
10	02	6	2					
						17	4050	2897
10	04	1	3	600	480			
10	04	2	1	200	160			
10	04	4	2					
						6	800	640
20	09	1	25	7500	6230			
20	09	2	2	600	390			
20	09	4	49					
20	09	6	7					
						83	8100	6620
20	21	1	2	900	600			
20	21	4	1					
100	02	1	1	75	60			
100	02	2	1	75	56			
						2	150	116
120	01	1	12	1500	1275			
120	01	2	2	250	210			
120	01	4	5					
120	01	6	3					
						22	1750	1485

FIG. 116

a section of the inventory is checked. Where differences occur, this statement facilitates the locating of errors.

Three journal entries are prepared for the accounting department from the next tabulation. The cards are sorted by type of entry and account number. The first journal entry records the distribution of sales of books and films. The second journal entry records the distribution of sales of the various journals, and the third analyzes the credit memos.

The final monthly tabulation deals only with taxable items. Totals are secured showing the total sales in the state of Illinois with a division between those that are taxable and those that are non-taxable, and the total of taxes billed. This is used in preparing a tax return required under the Retailer's Occupation Tax law in the state of Illinois.

At the close of the fiscal year, a physical inventory is taken. For this pur-

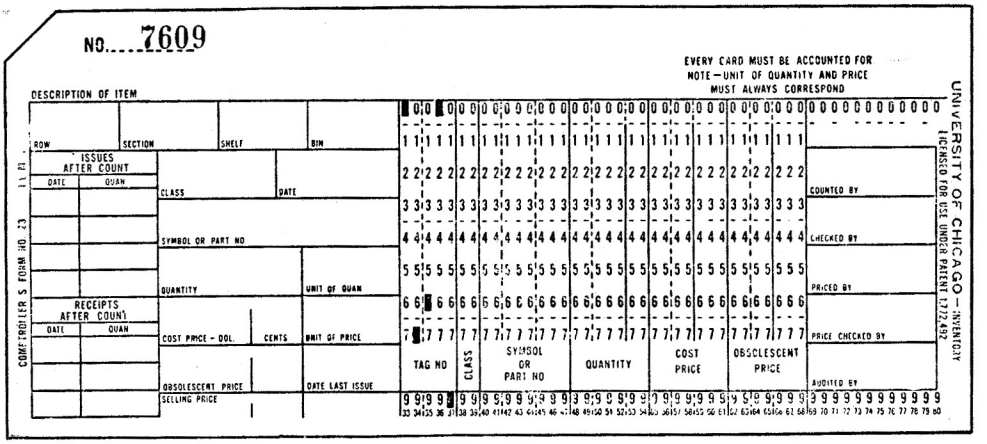


FIG. 117

pose special inventory cards are used. (Fig. 117.) These cards are numbered and the number prepunched at the factory when the cards are printed. As the cards are issued the numbers are recorded. To insure accuracy, all cards issued must be accounted for before the final tabulation begins.

A card is punched for each book showing:

Number of volumes on hand.
Inventory price last year.
Inventory price this year.
Sales volume classification.

These cards after being checked against the inventory record, are extended in groups according to the classification punched on the cards. The extensions of the inventory prices for this year and last year are accomplished by progressive digiting.

From the totals thus secured, journal entries are prepared showing the total value of the inventory, and the amount of the mark-down which is being charged to the past year's operations. The amount of the mark-down is based for each book on the volume of sales for the past year.

The inventory card described above is used in several departments besides The University of Chicago Press. It is used to calculate the inventories at the close of the fiscal year in the general storerooms, the bookstore, the clinical and hospital stores, and the laboratory supplies storeroom.

PART IV

Miscellaneous Administrative Applications

CHAPTER II

University Hospital Business Office*

By
GEORGE P. BUGBEE
Office Manager, University Hospital, University of Michigan.

SEVERAL years ago the University Hospital of the University of Michigan made a study of punched card tabulating methods and possible applications for such a system in the Business Office routine. As a result of that study certain parts of the clerical procedures were revised for use with punched cards. Eventually it is anticipated that the application will be much more general than at present.

The University Hospital admits patients sent from various governmental agencies under a variety of state acts providing for hospitalization. A relatively small number of cost and private patients are also admitted and pay for the expense of hospital care. The hospital has always found it advisable to keep detailed statistical analysis of information in regard to the patients registered in the Out-Patient Department and admitted to the In-Patient Department. It was practically impossible to prepare a report in sufficient detail by the usual manual method. The results before this analysis was put on punched cards were unsatisfactory; in spite of large expense the analysis did not provide all information desired.

At the present time a tabulating card (Fig. 118) is prepared for each patient admitted either to an Out-Patient or In-Patient department from the

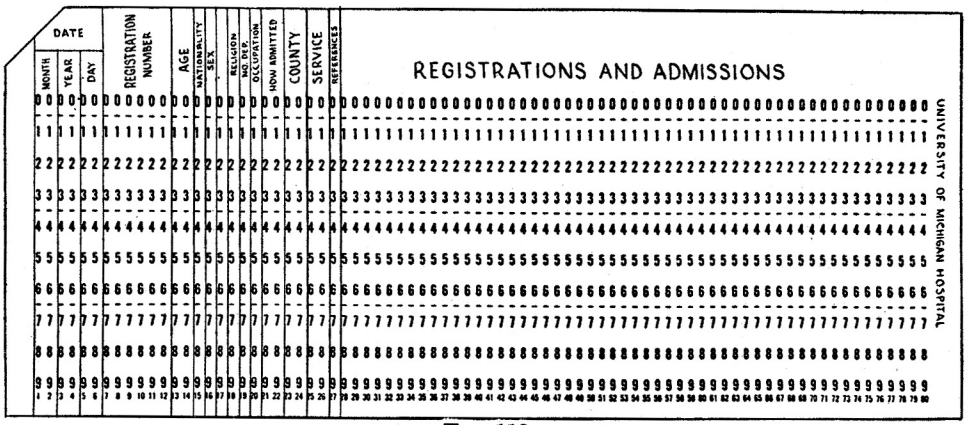
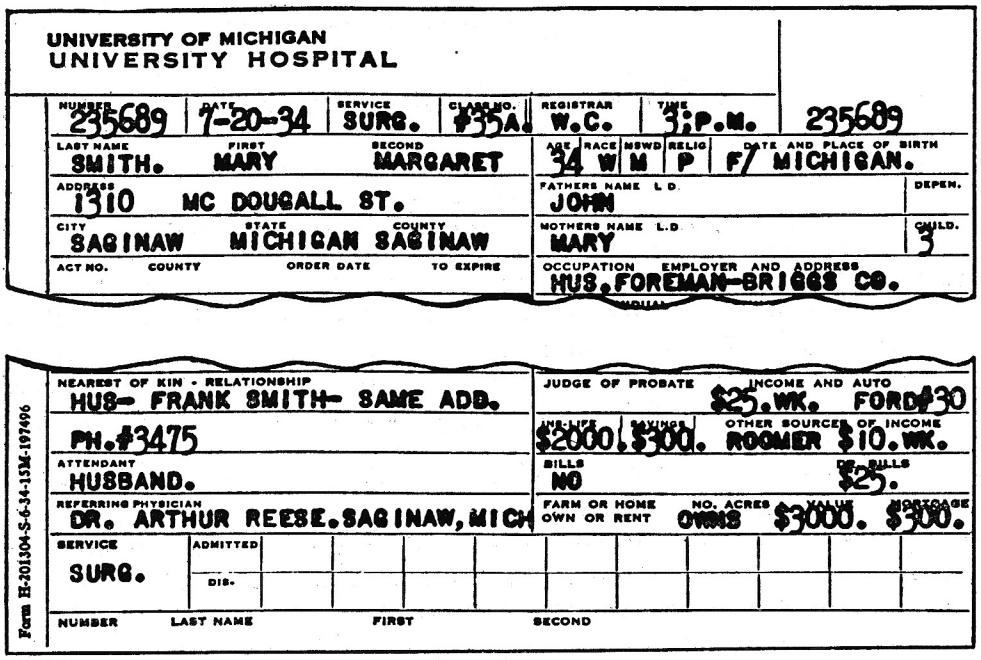


FIG. 118

* EDITOR'S NOTE: In connection with this topic see also pp. 99 and 241 to 316.

information secured from the registration record (Fig. 119) prepared at the time of admission. It is now possible to analyze, in any re-grouping, the information recorded on the card. We routinely analyze admission totals by the financial classification at the time of admission, by the county of residence, by age and in a variety of other ways. We very seldom find that we do not have prepared analyses of this information at any time it is required.



UNIVERSITY OF MICHIGAN
UNIVERSITY HOSPITAL

NUMBER	DATE	SERVICE	CLASS NO.	REGISTRAR	TIME	
235689	7-20-34	SURG.	#35A	W.C.	3:P.M.	235689

LAST NAME	FIRST	SECOND	AGE	RACE	M&WD	RELIG	DATE AND PLACE OF BIRTH
SMITH.	MARY	MARGARET	34	W	M	P	F/ MICHIGAN.

ADDRESS 1310 MC DOUGALL ST.
FATHERS NAME L.D. JOHN — DEPEN.
CITY SAGINAW STATE MICHIGAN COUNTY SAGINAW
MOTHERS NAME L.D. MARY — CHILD. 3
ACT NO. COUNTY ORDER DATE TO EXPIRE
OCCUPATION EMPLOYER AND ADDRESS HUS. FOREMAN-BRIGGS CO.

NEAREST OF KIN - RELATIONSHIP: HUS- FRANK SMITH- SAME ADD. PH. #3475
JUDGE OF PROBATE
INCOME AND AUTO: $25. WK. FORD $30
INS. LIFE: $2000. SAVINGS: $300.
OTHER SOURCES OF INCOME: ROOMER $10. WK.
ATTENDANT: HUSBAND.
BILLS: NO
DR. BILLS: $25.
REFERRING PHYSICIAN: DR. ARTHUR REESE. SAGINAW, MICH
FARM OR HOME OWN OR RENT: OWNS
NO. ACRES
VALUE: $3000.
MORTGAGE: $300.

SERVICE	ADMITTED											
SURG.	DIS.											

NUMBER LAST NAME FIRST SECOND

Form H-201304-S-6-34-15M-197496

FIG. 119
Registration sheet.

The preparation of special reports is easily accomplished from the information recorded on the cards and from time to time this has been of considerable value. Much information which was lost is now permanently recorded and available when needed.

Practice shows various philosophies existing in regard to the billing of charges for hospital service. This institution is entirely dependent on revenue from patients for its support. Business-like methods have been very necessary in order to preserve a balance between expense and revenue. Contrary to popular tendencies, this institution has avoided flat rate charges as a less business-like method. It is the belief that within practical limits each patient should be charged for the expense of his care. An endeavor is made to include in the room charge all small services, such as routine medication, dressings and diets. On the other hand, a patient who requires extensive service from the operating room, for anesthetics, and for special laboratory facilities should and does pay in proportion to use. In order to accumulate against each patient the special charges for the special services which he receives, it has been necessary to develop a method of accurately reporting charges, and posting to accounts receivable.

While the primary reason for special charges is an accurate account of the total expense for the treatment for any patient, there are other equally important reasons for this plan. An analysis of revenue by departments makes possible a comparison between expenses in any special department such as the X-ray Department, with the total revenue in that department. Thus for each service department a report is prepared showing the net financial results. This we consider a very important aid to management whether in the hospital or the manufacturing concern.

To enjoy the advantage last described it is, of course, necessary to analyze revenue carefully by the department earning that revenue. The principles of such an analysis are simple, requiring only the classification of revenue by departments and the accumulation of totals for each department. However, the clerical work involved is large. In addition to an analysis of revenue by departments the management wished to have an analysis of revenue by source of payment. Considering these two problems in relation to punched card processes, it was determined that each item of revenue could be put on a tabulating card (Fig. 120) with the designation of the department in which the revenue originates, the type of charge, and a designation of the financial classification of the patient to which the charge was assessed.

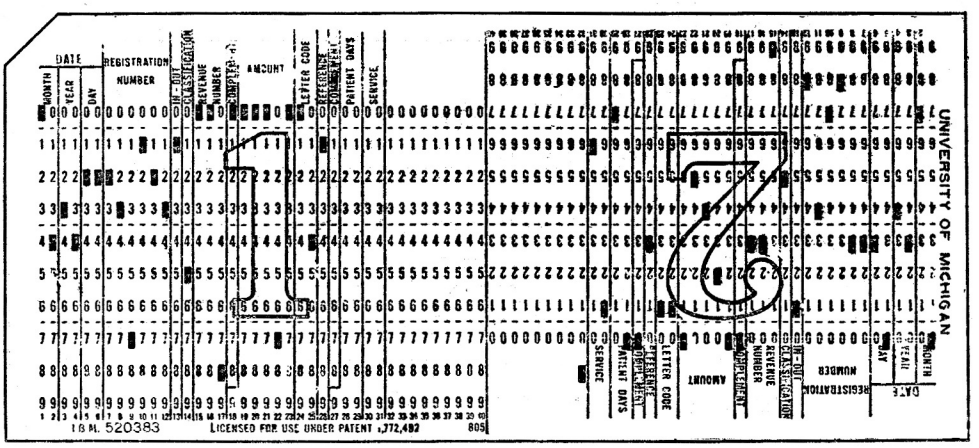


FIG. 120

Each of these forms has available on it the information required. The information is punched in the card and coded at the same time that it is punched. The card form shows the information recorded: date, patient registration number, classification indicating the source for payment of the account, whether the patient is an in-patient or an out-patient, the revenue classification number and certain other pertinent data, depending upon the type of charge. For instance room charges also carry a column indicating the number of patient days and the type of service.

Room charges are posted to patients' accounts from a photostatic copy of the alphabetical admitting files (Fig. 121). Special charges are posted

UNIVERSITY OF MICHIGAN
UNIVERSITY HOSPITAL
DAILY CHARGES TO PATIENTS

DATE 12-4-31

PATIENT	ROOM NO.	ROOM PRICE	NURSING DAY	NURSING NIGHT	DRESSINGS
NU 278828 ANTEAU.GEORGE JR.	5630	3.25			
SU 274129 APPLE,	3530	3.25			
SU 279196 AAPS. KEITH	6611	5.50			
MD 278 A	7107	3.50			
	6111	4.50			
250304 ARSENAULT.PAUL	SD2	3.00			
277000 ARTMAN.SYLVESTER F	SD1	3.00			
As-Ay					
OS	6307	6.50			

FIG. 121

from unit charge slips from each service department (Fig. 122).

UNIVERSITY HOSPITAL CHARGE SLIP H-201341-S-2-34-5M-195381

OUT PATIENT DEPARTMENT DATE 7/16/34

Abney, Alberta 250090
SURNAME FIRST INITIAL NUMBER

227 W. Washington St Jackson
STREET CITY

236 Jackson 10/9/33 Mich
CLASSIFICATION COUNTY STATE

CHARGE TO THE ABOVE THE FOLLOWING:

Bone & Joint Treatment		50
No. 2149 (421-out pat)		

FIG. 122

These cards now make possible the preparation of an analysis of revenue by department (Fig. 123), by type of revenue (Fig. 124), by the source of revenue (Fig. 125), and by in-patient and out-patient departments (Fig. 126). The same cards accumulate the patient days of care rendered patients sent here at county expense. A division of the total of revenue charges to these patients by the patient days rendered the same group yields a quotient which is the average charge assessed the group. This is an important index for

ROOM REVENUE - MAY 1934

- BY REVENUE NUMBER -

	REVENUE CODE	AMOUNT EACH REVENUE NUMBER	TOTAL AMOUNT	PATIENT DAYS EACH REVENUE NO.	TOTAL PATIENT DAYS
2 EAST	922	1710		6	
3 EAST	923	71610		248	
4 EAST	924	141255		445	
5 EAST	925	143275		462	
6 EAST	926	199215		699	
2 WEST	932	1140		4	
3 WEST	933	1425		5	
4 WEST	934	855		3	
5 WEST	935	3010		10	
6 WEST	936	15465		53	
4 PRIVATE	944	1770		5	
5 PRIVATE	945	123380		432	
INFANTS WARD	949	99999600			
PALMER 1	954	550		2	
EAST 1	957	2475		9	
EAST 2	958	825		3	
CONTAGIOUS	960	177700		357	
			885460		2737

FIG. 123

ROOM REVENUE - MAY 1934

- BY CLASSIFICATION -

CLASSIFICATION CODE	AMOUNT EACH CLASSIFICATION	TOTAL AMOUNT	PATIENT DAYS EACH CLASSIFICATION	TOTAL PATIENT DAYS
1	322750		1083	
2	155490		381	
3	293420		994	
4	15750		43	
5	96650		832	
6	1400		4	
		885460		2737

FIG. 124

MISCELLANEOUS REVENUE - MAY 1934

- BY CLASSIFICATION AND IN-OUT PATIENTS -

CLASSIFICATION CODE	IN-OUT	AMOUNT EACH IN-OUT	AMOUNT EACH CLASSIFICATION	GRAND TOTAL
1	1	11111		
	2	530		
			11641	
2	1	11644		
			11644	
3	1	4439		
	2	80		
			4519	
4	1	1545		
	2	70		
			1615	
5	1	13161		
	2	14749		
			27910	
6	1	4389		
			4389	
7	1	680		
			680	
9	2	4500		
			4500	
				66898

FIG. 126

MISCELLANEOUS REVENUE - MAY 1934

- BY REVENUE NUMBER, CLASSIFICATION AND IN-OUT -

	REVENUE CODE	CLASS	IN-OUT	AMOUNT EACH CLASSIFICATION AND IN-OUT	AMOUNT EACH REVENUE NUMBER	GRAND TOTAL
ADMINISTRATION	1					
REGISTRATION FEE	1					
		1	1	1800		
		1	2	5600		
		2	1	4600		
		2	2	14200		
		3	1	3000		
		3	2	8400		
		4	1	2600		
		4	2	3600		
		5	1	5500		
		5	2	267300		
		6	1	4600		
		6	2	1100		
		7	1	200		
					322500	
ADMINISTRATION	2					
SALVAGE SALES	2					
	2	5	2	211		
					211	
ADMINISTRATION	4					
INTEREST	4					
	4	5	1	1417		
					1417	
ADMINISTRATION	5					
LABORATORY FEE	5					
	5	1	1	99999500		
	5	5	1	54250		
	5	6	1	28500		
	5	7	1	500		
					82750	
						406878

FIG. 125

ROOM REVENUE - MAY 1934

- BY SERVICE -

and

REVENUE NUMBER -

SERVICE	SERVICE CODE NO.	REVENUE NUMBER	PATIENT DAYS EACH REVENUE NO.	PATIENT DAYS EACH SERVICE	GRAND TOTAL
BASAL METABOLISM	1				
BONE AND JOINT	2				
	2	923	236		
	2	924	435		
	2	925	454		
	2	926	613		
				1738	
CONTAGIOUS	3				
	3	935	1		
	3	935	2		
	3	936	8		
	3	945	4		
	3	949			
	3	954	2		
	3	957	9		
	3	958	3		
	3	960	357		
				386	
DERMATOLOGY	4				
	4	922	6		
	4	923	6		
	4	924	10		
	4	925	7		
	4	926	66		
	4	932	4		
	4	933	5		
	4	934	3		
	4	935	8		
	4	936	45		
	4	944	5		
	4	945	428		
				613	
					2737

FIG. 127

comparison with the flat rates which are now so often charged for hospital service.

The analysis of revenue has shown, as is so often true with mechanical sorting equipment, possibilities for securing many subsidiary reports, somewhat as by-products of the report for which the system was designed. Thus analyzing postings for room charges readily secures the total of patient days, by ward and by medical service (Fig. 127). In the same way the units of service in any given department can easily be secured. Such reports all save time elsewhere in the organization and add very little to the clerical work of preparing the tabulating cards for the general information required. One operator is now punching and verifying approximately 1,000 cards per eight hour day. Where necessary the operator codes directly from the original media.

Medical Records

For some months a very intensive study has been in progress by a committee appointed by the Executive Staff of the hospital, of the practicability of cataloguing medical record information by the punched card system. Effective July 1, an experimental system was put in operation. All medical record diagnoses, special therapy and certain other pertinent data are being catalogued on punched cards for reference for medical research by members of the staff.

In addition to a general plan for use of punched cards with medical records, various departments have been recording by this method certain medical data. The Pathology Department is recording in some detail the autopsy records. These are coded (Fig. 128), and then punched (Fig. 129). This information is

CODED BY JCB

CODE CARD

SERIAL NO 3934

First Card

UNIVERSITY OF MICHIGAN TABULATING STATION
220 ANGELL HALL

0	3	9	3	4	5	6	14	1	0	28	16	2	6	6	4	3	0		1
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
X0 56	X3 9	X3 45	X7 9	Y1 57	X7 9	YX 18	X7 9	Y1 78	X7 9	57 89	78 9	YX 67	YX 5	YX 23	YX 5	X2 46	YX 5	YX 18	YX 3
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
YX 02	YX 3			YX 25	67 8											X0 56	Y0 5	X3 47	Y0 5
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
X0 45	Y0 5	X0 15	Y0 5	67 89	Y1 5	YX 01	Y2 9	67 89	04 5			Y4 68	X7 9	Y2 45	X7 9	X0 18	X7 9	Y2 56	X7 9
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

I.B.M.—127959

FIG. 128

Autopsy Code Card

secured from the autopsy summary which, until this time, has been classified by manual methods for future reference (Fig. 130).

Another example is a report form used by the Cancer Clinic which is so designed that no coding at all is necessary, excepting physician's name. (Fig. 131).

The routines described above are those now in use in the Business Office. A study has been made of the payroll procedure, distribution of commodity

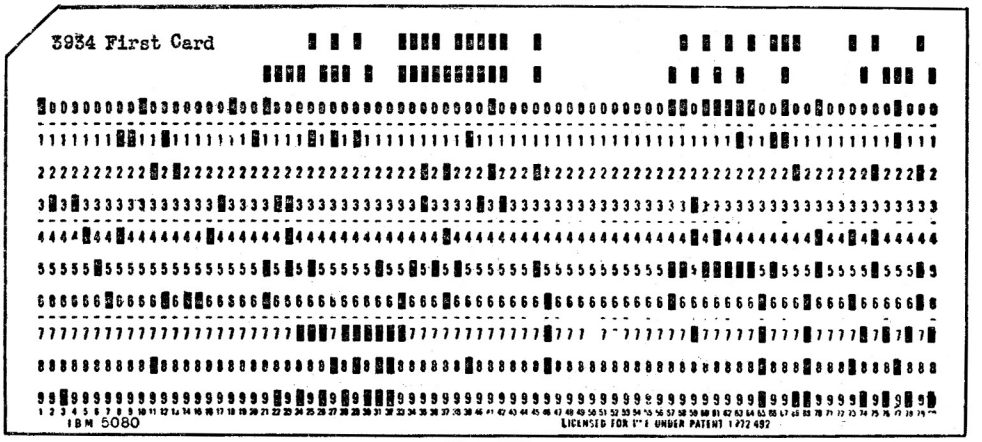


FIG. 129

Autopsy Punch Card

UNIVERSITY OF MICHIGAN
ANN ARBOR

UNIVERSITY HOSPITAL
DEPARTMENT OF PATHOLOGY

Autopsy Serial No. 3934 Hospital Registration No. 266430

C. S. Sex male. Age 56. Nationality Amer. Status married. Occupation ?

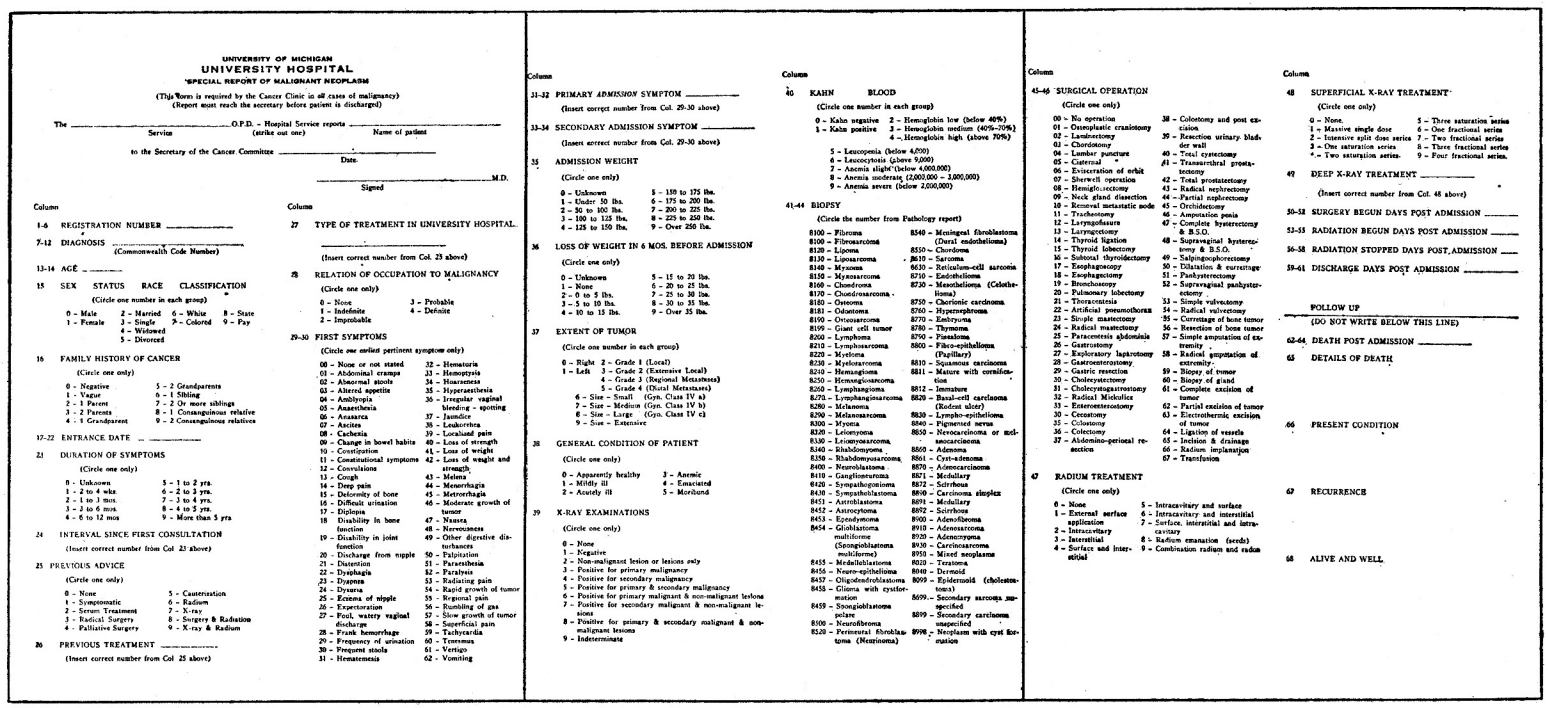
Clinic: G. U. Surgery. Kahn test ++++

Pathological Diagnosis: Primary medullary carcinoma of urinary bladder with extension to pelvic tissues, prostate, wall of rectum. Multiple metastases to regional and peribranchial lymphnodes, mesentery, peritoneum, liver, perinephric tissues and pancreas. Diphtheritic cystitis, prostatic urethritis, ureteritis and pyelitis. Chronic purulent prostatitis. Bilateral ascending chronic purulent pyelonephritis with pyonephrotic atrophy off the right. Chronic productive peritonitis. Serous atrophy of all adipose tissues. Cachexia. Purulent bronchitis and fibrino purulent lobular pneumonia. Emphysema. Active latent syphilis (myocarditis, aortitis, orchitis fibrosa, positive post-mortem Kahn reaction). Cardiac hypertrophy with terminal right-sided dilatation. Subepicardial fally infiltration and subendocardial fatty degenerative infiltration. Aortic atherosclerosis. Stasis catarrh of gastro-intestinal tract. Passive congestion and parenchymatous degeneration of all organs. Fibroid tubercles in pleura and bronchial nodes.

FIG. 130

Autopsy Summary Sheet

and personal service expense and the continuous inventory in the stockroom. These last functions are typical of like operations in any business concern. Tabulating equipment has been proved for this type of work and will readily adapt itself to the system here when conditions permit the re-organization required in changing.



UNIVERSITY OF MICHIGAN
UNIVERSITY HOSPITAL
SPECIAL REPORT OF MALIGNANT NEOPLASM

(This form is required by the Cancer Clinic in all cases of malignancy)
(Report must reach the secretary before patient is discharged)

The _____ O.P.D. - Hospital Service reports _____
Service (strike out one) Name of patient

to the Secretary of the Cancer Committee _____
Date.

_____ M.D.
Signed

Column

1-6 REGISTRATION NUMBER _____

7-12 DIAGNOSIS _____
(Commonwealth Code Number)

13-14 AGE _____

15 SEX STATUS RACE CLASSIFICATION
(Circle one number in each group)

0 - Male	2 - Married	6 - White	8 - State
1 - Female	3 - Single	7 - Colored	9 - Pay
	4 - Widowed		
	5 - Divorced		

16 FAMILY HISTORY OF CANCER
(Circle one only)

0 - Negative	5 - 2 Grandparents
1 - Vague	6 - 1 Sibling
2 - 1 Parent	7 - 2 Or more siblings
3 - 2 Parents	8 - 1 Consanguinous relative
4 - 1 Grandparent	9 - 2 Consanguinous relatives

17-22 ENTRANCE DATE _____

23 DURATION OF SYMPTOMS
(Circle one only)

0 - Unknown	5 - 1 to 2 yrs.
1 - 2 to 4 wks.	6 - 2 to 3 yrs.
2 - 1 to 3 mos.	7 - 3 to 4 yrs.
3 - 3 to 6 mos.	8 - 4 to 5 yrs.
4 - 6 to 12 mos.	9 - More than 5 yrs.

24 INTERVAL SINCE FIRST CONSULTATION
(Insert correct number from Col 23 above)

25 PREVIOUS ADVICE
(Circle one only)

0 - None	5 - Cauterization
1 - Symptomatic	6 - Radium
2 - Serum Treatment	7 - X-ray
3 - Radical Surgery	8 - Surgery & Radiation
4 - Palliative Surgery	9 - X-ray & Radium

26 PREVIOUS TREATMENT _____
(Insert correct number from Col 25 above)

Column

27 TYPE OF TREATMENT IN UNIVERSITY HOSPITAL
_____
(Insert correct number from Col. 25 above)

28 RELATION OF OCCUPATION TO MALIGNANCY
(Circle one only)

0 - None	3 - Probable
1 - Indefinite	4 - Definite
2 - Improbable	

29-30 FIRST SYMPTOMS
(Circle one earliest pertinent symptom only)

00 - None or not stated	32 - Hematuria
01 - Abdominal cramps	33 - Hemoptysis
02 - Abnormal stools	34 - Hoarseness
03 - Altered appetite	35 - Hyperaesthesia
04 - Amblyopia	36 - Irregular vaginal bleeding - spotting
05 - Anaesthesia	37 - Jaundice
06 - Anasarca	38 - Leukorrhea
07 - Ascites	39 - Localized pain
08 - Cachexia	40 - Loss of strength
09 - Change in bowel habits	41 - Loss of weight
10 - Constipation	42 - Loss of weight and strength
11 - Constitutional symptoms	43 - Melena
12 - Convulsions	44 - Menorrhagia
13 - Cough	45 - Metrorrhagia
14 - Deep pain	46 - Moderate growth of tumor
15 - Deformity of bone	47 - Nausea
16 - Difficult urination	48 - Nervousness
17 - Diplopia	49 - Other digestive disturbances
18 - Disability in bone function	50 - Palpitation
19 - Disability in joint function	51 - Paraesthesia
20 - Discharge from nipple	52 - Paralysis
21 - Distention	53 - Radiating pain
22 - Dysphagia	54 - Rapid growth of tumor
23 - Dyspnea	55 - Regional pain
24 - Dysuria	56 - Rumbling of gas
25 - Eczema of nipple	57 - Slow growth of tumor
26 - Expectoration	58 - Superficial pain
27 - Foul, watery vaginal discharge	59 - Tachycardia
28 - Frank hemorrhage	60 - Tenesmus
29 - Frequency of urination	61 - Vertigo
30 - Frequent stools	62 - Vomiting
31 - Hematemesis	

Column

31-32 PRIMARY *ADMISSION* SYMPTOM _____
(Insert correct number from Col. 29-30 above)

33-34 SECONDARY ADMISSION SYMPTOM _____
(Insert correct number from Col. 29-30 above)

35 ADMISSION WEIGHT
(Circle one only)

0 - Unknown	5 - 130 to 175 lbs.
1 - Under 50 lbs.	6 - 175 to 200 lbs.
2 - 50 to 100 lbs.	7 - 200 to 225 lbs.
3 - 100 to 125 lbs.	8 - 225 to 250 lbs.
4 - 125 to 150 lbs.	9 - Over 250 lbs.

36 LOSS OF WEIGHT IN 6 MOS. BEFORE ADMISSION
(Circle one only)

0 - Unknown	5 - 15 to 20 lbs.
1 - None	6 - 20 to 25 lbs.
2 - 0 to 5 lbs.	7 - 25 to 30 lbs.
3 - 5 to 10 lbs.	8 - 30 to 35 lbs.
4 - 10 to 15 lbs.	9 - Over 35 lbs.

37 EXTENT OF TUMOR
(Circle one number in each group)

0 - Right	2 - Grade 1 (Local)
1 - Left	3 - Grade 2 (Extensive Local)
	4 - Grade 3 (Regional Metastases)
	5 - Grade 4 (Distal Metastases)
6 - Size - Small	(Gyn. Class IV a)
7 - Size - Medium	(Gyn. Class IV b)
8 - Size - Large	(Gyn. Class IV c)
9 - Size - Extensive	

38 GENERAL CONDITION OF PATIENT
(Circle one only)

0 - Apparently healthy	3 - Anemic
1 - Mildly ill	4 - Emaciated
2 - Acutely ill	5 - Moribund

39 X-RAY EXAMINATIONS
(Circle one only)

0 - None	
1 - Negative	
2 - Non-malignant lesion or lesions only	
3 - Positive for primary malignancy	
4 - Positive for secondary malignancy	
5 - Positive for primary & secondary malignancy	
6 - Positive for primary malignant & non-malignant lesions	
7 - Positive for secondary malignant & non-malignant lesions	
8 - Positive for primary & secondary malignant & non-malignant lesions	
9 - Indeterminate	

Column

40 KAHN BLOOD
(Circle one number in each group)

0 - Kahn negative	2 - Hemoglobin low (below 40%)
1 - Kahn positive	3 - Hemoglobin medium (40%-70%)
	4 - Hemoglobin high (above 70%)
5 - Leucopenia (below 4,000)	
6 - Leucocytosis (above 9,000)	
7 - Anemia slight (below 4,000,000)	
8 - Anemia moderate (2,000,000 - 3,000,000)	
9 - Anemia severe (below 2,000,000)	

41-44 BIOPSY
(Circle the number from Pathology report)

8100 - Fibroma	8540 - Meningeal fibroblastoma (Dural endothelioma)
8100 - Fibrosarcoma	
8120 - Lipoma	8550 - Chordoma
8130 - Liposarcoma	8630 - Sarcoma
8140 - Myxoma	8630 - Reticulum-cell sarcoma
8150 - Myxosarcoma	8710 - Endothelioma
8160 - Chondroma	8730 - Mesothelioma (Celothelioma)
8170 - Chondrosarcoma	
8180 - Osteoma	8750 - Chorionic carcinoma
8181 - Odontoma	8760 - Hypernephroma
8190 - Osteosarcoma	8770 - Embryoma
8199 - Giant cell tumor	8780 - Thymoma
8260 - Lymphoma	8790 - Pinealoma
8210 - Lymphosarcoma	8800 - Fibro-epithelioma (Papillary)
8220 - Myeloma	
8230 - Myelosarcoma	8810 - Squamous carcinoma
8240 - Hemangioma	8811 - Mature with cornification
8250 - Hemangiosarcoma	
8260 - Lymphangioma	8812 - Immature
8270 - Lymphangiosarcoma	8820 - Basal-cell carcinoma (Rodent ulcer)
8280 - Melanoma	
8290 - Melanosarcoma	8830 - Lympho-epithelioma
8300 - Myoma	8840 - Pigmented nevus
8320 - Leiomyoma	8850 - Nevocarcinoma or melanocarcinoma
8330 - Leiomyosarcoma	
8340 - Rhabdomyoma	8860 - Adenoma
8350 - Rhabdomyosarcoma	8861 - Cyst-adenoma
8400 - Neuroblastoma	8870 - Adenocarcinoma
8410 - Ganglioneuroma	8871 - Medullary
8420 - Sympathogonioma	8872 - Scirrhous
8430 - Sympathoblastoma	8890 - Carcinoma simplex
8451 - Astrocytoma	8891 - Medullary
8452 - Astrocytoma	8892 - Scirrhous
8453 - Ependymoma	8900 - Adenofibroma
8454 - Glioblastoma multiforme (Spongioblastoma multiforme)	8910 - Adenosarcoma
	8920 - Adenocystoma
	8930 - Carcinosarcoma
	8950 - Mixed neoplasms
8455 - Medulloblastoma	9020 - Teratoma
8456 - Neuro-epithelioma	8040 - Dermoid
8457 - Oligodendroblastoma	8099 - Epidermoid (cholesteatoma)
8458 - Glioma with cystformation	8699 - Secondary sarcoma unspecified
8459 - Spongioblastoma polare	8899 - Secondary carcinoma unspecified
8500 - Neurofibroma	8998 - Neoplasm with cyst formation
8520 - Perineural fibroblastoma (Neurinoma)	

Column

45-46 SURGICAL OPERATION
(Circle one only)

00 - No operation	38 - Colostomy and post excision
01 - Osteoplastic craniotomy	
02 - Laminectomy	39 - Resection urinary bladder wall
03 - Chordotomy	
04 - Lumbar puncture	40 - Total cystectomy
05 - Cisternal "	41 - Transurethral prostatectomy
06 - Evisceration of orbit	
07 - Sherwell operation	42 - Total prostatectomy
08 - Hemiglossectomy	43 - Radical nephrectomy
09 - Neck gland dissection	44 - Partial nephrectomy
10 - Removal metastatic node	45 - Orchidectomy
11 - Tracheotomy	46 - Amputation penis
12 - Laryngofissure	47 - Complete hysterectomy & B.S.O.
13 - Laryngectomy	
14 - Thyroid ligation	48 - Supravaginal hysterectomy & B.S.O.
15 - Thyroid lobectomy	
16 - Subtotal thyroidectomy	49 - Salpingocophorectomy
17 - Esophagoscopy	50 - Dilatation & curettage
18 - Esophagectomy	51 - Panhysterectomy
19 - Bronchoscopy	52 - Supravaginal panhysterectomy
20 - Pulmonary lobectomy	
21 - Thoracentesis	53 - Simple vulvectomy
22 - Artificial pneumothorax	54 - Radical vulvectomy
23 - Simple mastectomy	55 - Curettage of bone tumor
24 - Radical mastectomy	56 - Resection of bone tumor
25 - Paracentesis abdominalis	57 - Simple amputation of extremity
26 - Gastrostomy	
27 - Exploratory laparotomy	58 - Radical amputation of extremity
28 - Gastroenterostomy	
29 - Gastric resection	59 - Biopsy of tumor
30 - Cholecystectomy	60 - Biopsy of gland
31 - Cholecystogastrostomy	61 - Complete excision of tumor
32 - Radical Mickulicz	
33 - Enteroenterostomy	62 - Partial excision of tumor
34 - Cecostomy	63 - Electrothermic excision of tumor
35 - Colostomy	
36 - Colectomy	64 - Ligation of vessels
37 - Abdomino-perineal resection	65 - Incision & drainage
	66 - Radium implantation
	67 - Transfusion

47 RADIUM TREATMENT
(Circle one only)

0 - None	5 - Intracavitary and surface
1 - External surface application	6 - Intracavitary and interstitial
	7 - Surface, interstitial and intracavitary
2 - Intracavitary	
3 - Interstitial	8 - Radium emanation (seeds)
4 - Surface and interstitial	9 - Combination radium and radon

Column

48 SUPERFICIAL X-RAY TREATMENT
(Circle one only)

0 - None.	5 - Three saturation series
1 - Massive single dose	6 - One fractional series
2 - Intensive split dose series	7 - Two fractional series
3 - One saturation series	8 - Three fractional series
4 - Two saturation series	9 - Four fractional series.

49 DEEP X-RAY TREATMENT _____
(Insert correct number from Col. 48 above)

50-52 SURGERY BEGUN DAYS POST ADMISSION _____

53-55 RADIATION BEGUN DAYS POST ADMISSION _____

56-58 RADIATION STOPPED DAYS POST ADMISSION _____

59-61 DISCHARGE DAYS POST ADMISSION _____

FOLLOW UP
(DO NOT WRITE BELOW THIS LINE)

62-64 DEATH POST ADMISSION _____

65 DETAILS OF DEATH

66 PRESENT CONDITION

67 RECURRENCE

68 ALIVE AND WELL

162

FIG. 131

PART IV

Miscellaneous Administrative Applications

CHAPTER III

University Extension

By
E. J. KENDALL
Service Manager, LaSalle Extension University, Chicago, Ill.

THE University which is operated on an international scale, enrolls approximately 40,000 students each year in its 42 courses. Most of these enrollments are on an installment basis of tuition, with prices and terms varying according to the course and territory. Enrollments are secured by mail and through district registrars and branch offices.

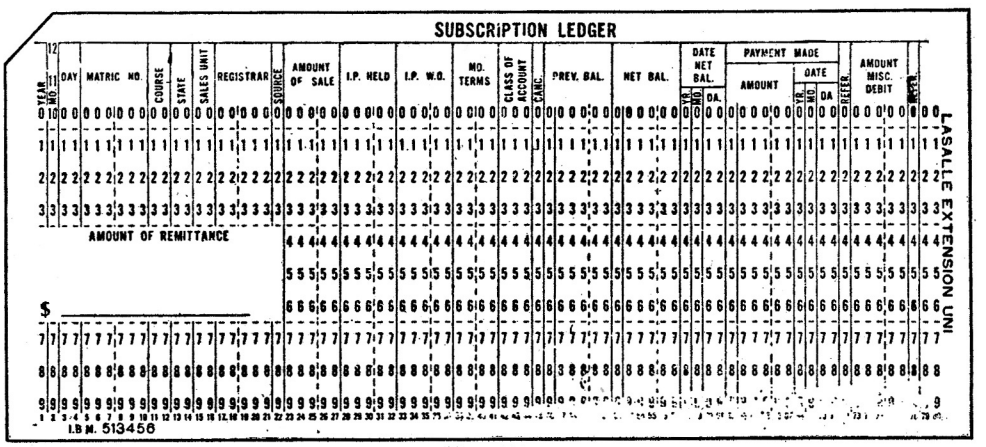


FIG. 132

We use an 80-column Hollerith card (Fig. 132), a master card being punched immediately on receipt of the enrollment. From this card we make a weekly and monthly analysis of our enrollments (Fig. 133). As payments are received, they are posted on to the card, which is then immediately reproduced, changing the net balance and the previous balance, and leaving the card open from columns 63 to 80 for the next posting. The master card is then transferred to the "payment made" file where it is made available for statistical analysis of realization which is broken down into several divisions. We are, of course, vitally interested in preparing analyses on realization by course, by territory, by terms of payment, by sales unit and salesman, so that we know at all times our ultimate realization expectancy.

Previous payment (Codes)	Nature of entry (cash, discount, etc.)	Kind of fee	File number	Course	Previous balance.	Cash received.	Class of account, (open, delinquent, etc.)	Cancellations	Account number, total (for proof only)
244503	0	0	781977	02	2000	600	20680	0	
214430	0	0	782415	02	13800	600	994	1	
714512	0	0	782424	02	13400	200		1	
474511	0	0	782625	03	6100	600			
374212	0	0	782749	03	11800	1200	20990	0	
374126	0	0	782752	11	6600	200	20990	0	
44517	0	0	783213	03	5900	800	990	0	
124510	0	0	783234	03	4200	750	990	0	
54515	0	0	783303	03	1000	800	20600	0	
244514	0	0	783431	01	2000	600	690	0	
124515	0	0	783479	05	8500	250	994	0	
784515	0	0	783673	02	11800	500	990	0	
314514	0	0	790495	03	7600	800	990	0	
344427	0	0	790695	01	11300	600	990	0	
124504	0	0	790769	02	7300	600	990	0	
44514	0	0	790965	03	5700	800	610	0	
					373175	38823	524886	2	47137470

FIG. 133

The advantages of this system as compared with the old-time Boston ledger carrying ten accounts to a sheet, are as follows:

The files are always complete at the end of each day. All posting work is controlled by a predetermined total. Where it took the equivalent of 100 hours of labor to draw off a trial balance of approximately 30,000 accounts on the old system, we can now obtain the same information in about 6½ hours, including reconciliation of general ledger accounts.

By dividing the Accounts Receivable into classes, we find a distinct advantage in the Hollerith Method as compared to the old ledger. Once an account was entered in sequence in the old ledger, it could be classified only by symbol, which necessitated checking an entire ledger in order to make an inventory of any class of account. Now a number punched on the Hollerith card in the "class of account" column enables us to sort out in a very short time all of the accounts of similar classification. This is invaluable in keeping records of accounts scheduled as collateral, etc. (See Fig. 134).

Inasmuch as the accounts are being constantly weeded out as they become paid in full, the files never become overloaded. We have been operating with the same amount of equipment, consisting of a filing cabinet of 24 trays, for eight years, and still have available space for new accounts. The old system was an endless array of ledger binders, always becoming more dilapidated as time went on, and still never dispensable.

We have effected a saving of approximately $6,000 per year and obtain in addition, any desired number of statistical analyses, as a by-product, without added cost.

DEPOSIT OF COLLATERAL

Date_____ Trust No._____ Sheet No._____

Class of Account	Account Number	Course	Gross Balance	Credits	Net Balance	Date of Net Balance
4	818202	02	16000	1000	15000	4 5 28
4	818203	02	16000	1500	14500	4 5 28
4	818204	02	16000	1500	14500	4 5 28
4	818205	02	16000	1000	15000	4 5 28
4	818206	02	16000	1000	15000	4 5 28
4	818207	02	16000	1500	14500	4 5 28
4	818208	02	16000	1000	15000	4 5 28
4	818210	02	16000	1000	15000	4 5 28
4	818212	02	16000	1000	15000	4 5 28
4	818213	02	16000	1500	14500	4 5 28
[illegible]						
4	818312	03	19700	1000	18700	4 5 29
4	818313	03	19700	1000	18700	4 5 29
4	818314	03	12500	1000	11500	4 5 29
4	818315	11	13000	1500	11500	4 5 29
4	818316	11	12400	1000	11400	4 5 29
4	818321	02	16000	1000	15000	4 5 29
4	818322	02	16000	2000	14000	4 5 29
4	818323	02	16000	1000	15000	4 5 29
			919400	71000	848400	

FIG. 134

We hope to find the time to apply a system using the Hollerith equipment for our lesson record registers and also for our system of billing. Our plans in this regard are already well advanced and we look forward to their realization in the near future.

PART IV

Miscellaneous Administrative Application

CHAPTER IV

A Central Tabulating Department

By
ALAN D. MEACHAM
Instructor in charge, Tabulating Station, University of Michigan

THE Tabulating Department of the University of Michigan was established primarily for the purpose of instructing students from the Schools of Business Administration and Education, and the Departments of Mathematics, Hygiene and Public Health, and Sociology in the advantages and technique of Punched Card Statistical and Accounting Machines.

We have a complete set of punching, verifying, and sorting equipment, in addition to a set of alphabetical machines.

Students of the above courses are given a lantern slide lecture showing various card forms and machines. This lecture serves as an introduction to the actual demonstration which follows in the Tabulating Machine Laboratory. Occasionally arrangements are made for showing films, provided by the punched card companies, to larger audiences. In this connection tabulating cards (Fig. 135) are used to automatically count the number of persons expected to attend.

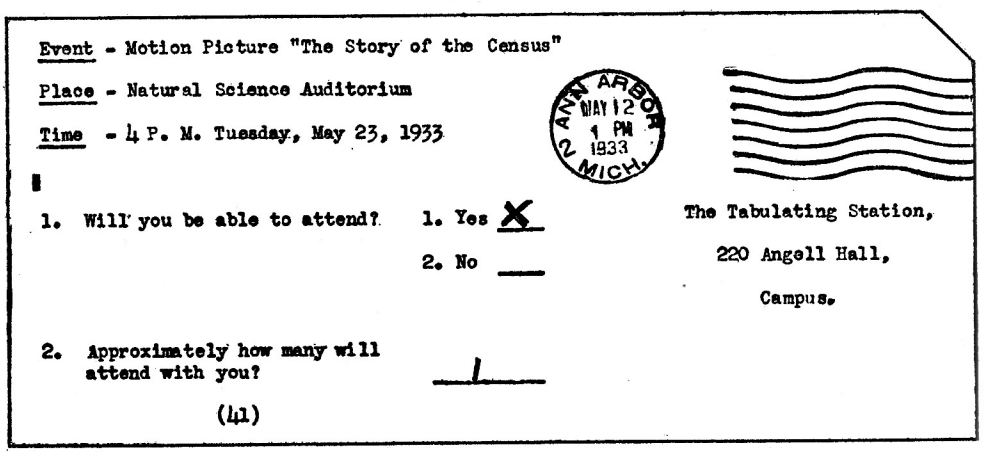


FIG. 135

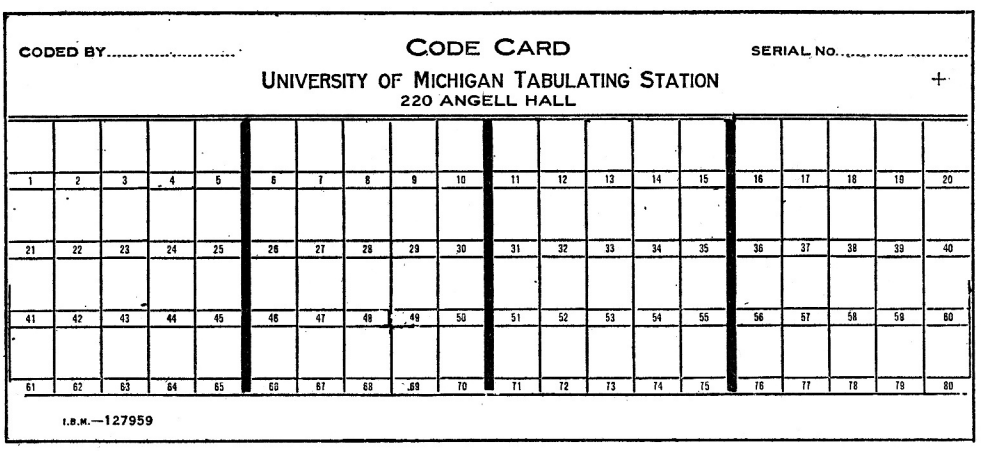
In the Laboratory the students are given a detailed description of the operation of each machine and an opportunity to ask questions as to the efficiency of punched cards in comparison with hand methods. Frequently students will have a personal problem that can well be carried out on punched cards and

they are given the advice and help necessary to plan their project most efficiently. They can punch and verify their work themselves, thus avoiding the most costly part of the tabulating procedure. The actual sorting and tabulating is done by experienced clerks in the Tabulating Department who are on call for this type of work. The student is billed only for the cost of the cards and the labor necessary for doing the tabulating. There is no charge for machine time.

In addition to assisting students, the Department will also turn out work for any department on the campus which is in need of mechanical tabulation. Scores of special studies have been tabulated for a number of different departments on the campus, among them:

Bureau of Business Research
Bureau of Educational Investigations
Bureau of Educational Reference and Research
School of Forestry and Conservation
Bureau of Appointments and Occupational Information
Office of the Registrar
Legal Research Institute
University Health Service
University Hospital
Department of Chemical Engineering, etc.

Many departments turn over to this central station their entire routine work. After the data are punched in their own department the cards are sent to the Tabulating Department where they are sorted and tabulated. Where extensive coding of the original data is required, a special card form (Fig. 136) is filled in as an intermediary step to provide operators with a simple record from which to punch. This is done either by the central bureau or the respective departments.


CODED BY.....

CODE CARD

SERIAL NO.....

UNIVERSITY OF MICHIGAN TABULATING STATION
220 ANGELL HALL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

I.B.M.—127959

FIG. 136

Each campus department having projects of this kind is charged by the Tabulating Department for the material, cost of punching and verifying equip-

TABULATING DEPT. TIME RECORD

CHARGE TO:

I. D. REQ. NO.:

OPERATOR:

DATE. MONTH. YEAR.

Day	Punch	Ver	Sort	Tab	Cler	Machine Hrs.	Actual Hrs.
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
Hrs.							
Amt.							

Remarks:

Form 4359 6-34 1M

FIG. 137

ment installed in its own department, and labor of tabulating. The cost of the sorting and tabulating machines is paid out of a general appropriation made for this express purpose.

Lastly, the services of this Station are at the disposal of any governmental department within the State, whether state, city or federal. However, *outside projects* must pay the full cost of machines in addition to a labor charge and service charge.

Our method of keeping costs is simple but effective. Each machine in the department has 182 available hours each month. There are six machines. Total available time for all machines is, therefore, 1092 hours per month. (This is based on the University week of 42 hours, 12 months a year.)

If an operator comes in and works for eight hours and during those eight hours does 6.0 hours tabulating, 3.0 hours sorting (while the tabulator is running) and 2.0 hours punching, then we have 11.0 hours of machine time, and 8.0 hours of actual operator time. Machine hours are recorded on a card (Fig. 137) while operators' hours are indicated on a small time slip (Fig. 138). Once a month tabulating cards (Fig. 139) are punched from the foregoing and tabulated to show operator hours by departments, hours by machines and machine hours by departments.

Advice and consultation is given gladly and is entirely gratis for all outside work, but for projects other than governmental or educational the Department does not care to do anything beyond advising and suggesting possible methods to be used.

A central tabulating installation such as this can be made practically self-supporting, but up to the present we have found it more convenient to charge only for material and labor on all inter-departmental projects, leaving the machine rentals to come from a special appropriation. In this connection one of the last financial statements of the department may be of interest (Fig. 140).

DATE

NAME

KIND OF WORK

7:00	7:06	7:12	7:18	7:24	7:30	7:36	7:42	7:48	7:54	12:00
8:00	8:06	8:12	8:18	8:24	8:30	8:36	8:42	8:48	8:54	
9:00	9:06	9:12	9:18	9:24	9:30	9:36	9:42	9:48	9:54	
10:00	10:06	10:12	10:18	10:24	10:30	10:36	10:42	10:48	10:54	
11:00	11:06	11:12	11:18	11:24	11:30	11:36	11:42	11:48	11:54	
1:00	1:06	1:12	1:18	1:24	1:30	1:36	1:42	1:48	1:54	6:00
2:00	2:06	2:12	2:18	2:24	2:30	2:36	2:42	2:48	2:54	
3:00	3:06	3:12	3:18	3:24	3:30	3:36	3:42	3:48	3:54	
4:00	4:06	4:12	4:18	4:24	4:30	4:36	4:42	4:48	4:54	
5:00	5:06	5:12	5:18	5:24	5:30	5:36	5:42	5:48	5:54	

TOTAL TIME	HOUR	TENTHS
A. M.		
P. M.		
TOTAL		

CHECKED

TIME CLERK

600 (7-29) 30M S

FIG. 138

Operators Time Slip

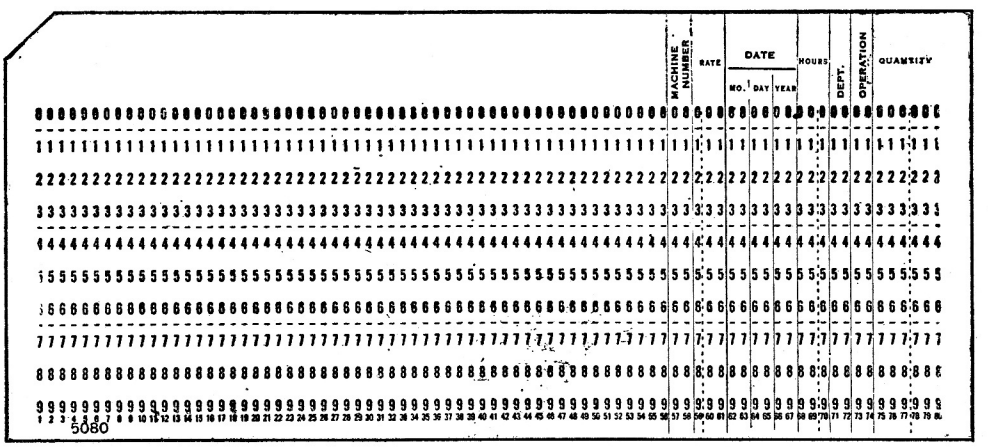


FIG. 139

Cost Distribution Card.

The generosity of the punched card companies in making available their literature and help together with other valuable assistance has meant that this Department has been able to do a great deal more for the advancement of the Art of Punch Hole Statistics than would be otherwise possible.

SORTING AND TABULATING STATION
FINANCIAL STATEMENT
FOR THE YEAR ENDED JUNE 30th., 1933

EXPENSES CLASSFIED			
Salaries Clerks and stenographers	1,865.50		
Unclassified service	2,300.00		
Communication service	19.40		
Stationery and Office supplies	296.66		
Publications and Printing	13.00		
Freight, Express and Drayage	130.05		
Equipment repairs	1.25		
General supplies and Rentals	4,395.05		
Total Expense		9,020.91	
Expenditure for Equipment		170.81	
Total Cost of Department			9,191.72
Income Classified			
Department Transfers		683.03	
Income from Sales and Services			
Other Services (Outside)	1,497.99		
Sales of Supplies	93.25		
Material Returned and Rebates	2,306.48		
		3,897.72	
Total Credit to Department			4,580.75
Net cost of sorting and Tabulating Department			4,610.97

FIG. 140

PART IV

Miscellaneous Administrative Applications

CHAPTER V

Fraternities

By
R. E. IFFERT
Assistant Director of the Bureau of Educational Records and Research, Pittsburgh, Pa.
Formerly Instructor, University of Pittsburgh

THAT fraternities, sororities and other scholastic associations may well emulate the example set by progressive university administrations in applying the punched card method to many phases of their administrative work has been demonstrated by a questionnaire survey recently completed by Phi Delta Kappa, a professional education fraternity. This study was carried on at the University of Pittsburgh by a committee of which Dr. Walter B. Jones, National Secretary of the fraternity, was chairman.

Three thousand questionnaires (Fig. 141) were received from members of this association representing 42 chapters in five districts. 51 tables based on these data were included in the final report of the survey committee.

Codes had been previously established for all pertinent data, so that the coding of the questionnaires which was done by the committee staff was not a difficult task. The coded questionnaires were turned over to the local Tabulating Service Bureau, which punched a card (Fig. 142) for each one.

The nature of breakdowns and listings is indicated by the following representative table headings:

A distribution of replies to survey questionnaire by chapters.
Distribution of membership by age groups.
Distribution of membership by salary groups.
A distribution of the salaries received in 1929-30 according to the salaries received in 1932-33, to show salary trends.
Distribution according to number of education organizations to which members belong.
Annual expenditure for membership fees in professional organizations.
A distribution of the replies to the question "Do you consider the annual NATIONAL membership fee too high?" according to the district in which membership is held.
A distribution of the replies to the question "Do you favor the national office as the collecting agency for your annual membership fees?" according to the district in which chapter membership is held.
A distribution of the replies to the question "Do you consider the present magazine content worthy of and in keeping with the best interests of the fraternity?" according to the standing of the members in the fraternity.
A distribution of 2977 questionnaire replies by standing in the fraternity.
A distribution of the replies to the question, "Do you consider the annual ACTIVE CHAPTER membership fee too high?" according to the status of the members in the fraternity.
A distribution of the replies to the question "What additional principles do you recognize as fundamental Phi Delta Kappa policy?" according to the highest academic degree received.
A distribution of the replies to the question "Do you consider the annual NATIONAL membership fee too high?" according to salary groups.
A distribution of the replies to the question "Do you consider the annual ACTIVE CHAPTER membership fee too high?" according to salary groups.

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SURVEY COMMITTEE OF NATIONAL ORGANIZATION OF PHI DELTA KAPPA
Walter R. Jones, Chairman
809 Cathedral of Learning, University of Pittsburgh, Pittsburgh, Pa.

Name John Doe Chapter XI-452 1445219

(Please note that the information given herein is solely for the purpose of this survey and that it is not to be used in connection with my name either in connection with the report of the committee or in any published report.)

1. Position held at present Supt. of Schools 2
2. Name of institution or school Cornerstone, P.
3. How long in present position? 4 yrs In previous position 6 yrs 0406
4. Highest academic degree received M.A. Institution U. of Pgh. 3
5. Age group (Please check the group appropriate to your age)
   Under 30 ___ 30-29 ___ 30-39 ✓ 40-50 ___ above 50 ___ 3
6. Salary group for 1929-30 and again for 1932-33 (Check for each year)

1929-1930: (12 months)	Under $1500	$1500-1999	$2000-2499	$2500-2999	
	$3000-3499 ✓	$3500-3999	$4000-4999	$4500-4999	
	$5000-5999	$6000-7000	Above $7000		05
1932-1933: (12 months)	Under $1500	$1500-1999	$2000-2499	$2500-2999 ✓	
	$3000-3499	$3500-3999	$4000-4999	$4500-4999	
	$5000-5999	$6000-7000	Above $7000		04

7. Have you been unemployed at any time since 1929 due to current policy of retrenchment and drastic economies? No If so, for how long? ___ 1
8. Are you at present unemployed for the next school year? No 1
9. Do you agree with the fundamental principles and their implications as outlined in the statement of purpose and policy which accompanies this questionnaire? No If not, with which ones do you disagree and why? Number 2. Public school employees should not participate in any political activities 27

What additional principles do you recognize as fundamental Phi Delta Kappa policy? More emphasis on good classroom teaching 4

- 2 -

10. Number of education organizations to which you pay dues, including PDK, such as N.E.A., Dept. of Supt., Kappa Delta Pi, etc. 4 4
11. Total annual expenditure for membership fees which you pay to above organizations, including PDK $12.00 8
12. Do you consider the annual national membership fee of PDK too high? No 1
13. Do you consider the annual active chapter membership fee too high? No 1
14. Do you pay an annual membership fee to an alumni chapter of PDK? No 1
15. Do you consider the present practice of a national membership fee plus an active chapter fee plus an additional alumni chapter fee (for members of alumni chapters) a satisfactory financial basis for the support of the national organization and the local chapters? yes 2
16. If not, what recommendations do you have for a change? 0
17. Do you favor the active chapter or the national office as the collecting agency for your annual membership fees? yes 2
18. State your reasons for above preference More direct contact 1
19. Please check the type of contacts which you recall having had with your chapter and with the national office during the period of your membership.

Please rank these contacts with the fraternity in the order of greatest importance and helpfulness to you.

Fraternity Contacts, PDK	Check	Rank	
Correspondence with the chapter	✓	6	6
Correspondence with the national office			0
Chapter news letters, either printed or mimeographed	✓	3	3
The national directory, 1931	✓	4	4
Letters for collection of dues from chapter	✓	7	1
The Phi Delta Kappan, national magazine	✓	2	2
Chapter bulletins such as theses abstracts, etc			0
Alumni Chapter news letters			0
Active Chapter meetings	✓	1	1
Alumni Chapter meetings			0
National luncheon and dinner meetings	✓	5	5
State-wide or sectional fraternity meetings			0

- 3 -

20. What returns for your membership fee do you value most highly as a field or alumni member? (1) Local chapter meetings 3
    (2) ___ 0
21. In what respects do you recommend a revision of policy in regard to ways and frequency of contact on the part of the national organization? 0
22. On the part of active chapters? 0
23. On the part of alumni chapters? 0
24. The fraternity has required for many years that each initiate be supplied with a fraternity pin. The cost is covered by the initiation fee. In your judgment, is this an essential fraternity practice? No
    Do you recommend that the requirement be continued or discontinued? Discontinued 1
25. The National Magazine — The Phi Delta Kappan
    a. Do you prefer that the magazine be developed as more of a "house organ" and less as a professional journal? Professional journal 1
    b. Do you prefer that the magazine regularly devote a section to personals and chapter news? No 1
    c. Do you consider the present magazine content worthy of and in keeping with the best interests of the fraternity? Yes 2
    d. Do you think articles should be more scientific in character? Yes 2
    e. Do you find the author's section helpful? Yes 2
    f. Suggestions for improvement and criticisms (favorable or unfavorable) Include abstracts of dissertations 3
26. Criticisms or suggestions for the good of the fraternity: Devote more effort to professionalizing educators 6

FIG. 141

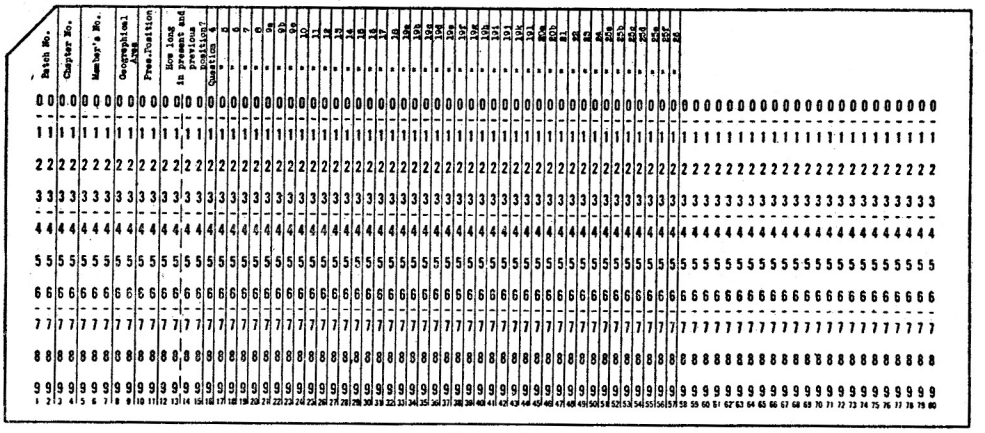

FIG. 142

A distribution of the replies to the question "What returns for your membership fee do you value most highly?" according to position held.

A distribution of the replies to the question "What returns for your membership fee do you value as second in importance?" according to the highest academic degree received.

A distribution of the replies to the question "What returns for your membership fee do you value as second in importance?" according to year initiated.

A summary distribution of the replies to the questions "What returns for your membership fee do you value most highly?" and "What returns for your membership fee do you value as second in importance?" without regard to position held, highest academic degree received, or date of initiation.

A distribution of the replies to the question "Do you prefer that the magazine be developed as more of a 'house organ' and less as a professional journal?" according to year initiated.

A distribution of the replies to the question "Do you prefer that the magazine regularly devote a section to personals and chapter news?" according to year initiated.

A distribution of the replies to the question "Do you prefer that the magazine regularly devote a section to personals and chapter news?" according to position held.

A distribution of the replies to the question "Do you consider the present magazine content worthy of and in keeping with the best interests of the fraternity?" according to the highest academic degree received.

A distribution of the replies to the question "Do you consider the present magazine content worthy of and in keeping with the best interests of the fraternity?" according to position held.

A distribution of the replies to the question "Do you think articles should be more scientific in character?" according to year initiated.

A distribution of the replies to the question "Do you think articles should be more scientific in character?" according to the highest academic degree received.

A distribution of the replies to the question "Do you think articles should be more scientific in character?" according to position held.

The variety of reports serves as an excellent example of the flexibility of the punched card method. All of them were prepared from the one set of tabulating cards. In a study such as this in which it is important to know not only "what is said," but also "who said it," the tabulating machine method is extremely valuable in compiling the data.

It is interesting to note that prior to the committee's decision to utilize the tabulating machine method one thousand similar questionnaires had been hand tabulated at a cost approximately four times as great as that of the machine tabulation. If one considers that this saving was accompanied by a higher degree of accuracy and much greater speed than is possible under any manual method, the advantage of the Electric Tabulating Machines for work of this type becomes even more apparent.

It is our belief that any individual or group of individuals responsible for circulating a questionnaire, assumes an obligation to those who respond to make every possible significant analysis of the responses and to make the results available to the respondents. The reputation of the questionnaire might be considerably enhanced if more thorough analyses and reports were made of the responses. The questionnaire is frequently more objective if the form is devised to meet the requirements of the tabulating machine method of compiling the report. In other words, questions requiring specific rather than general answers will be prepared. This should decrease the difficulty in answering the questions and, in turn, increase the percentage of the returns.

PART V

Applications in Psychology and Educational Research

PART V

Applications in Psychology and Educational Research

CHAPTER I

Questionnaire Construction and Analysis

By

HERBERT A. TOOPS

Professor of Psychology, Ohio State University

AS in most applications of Hollerith equipment, both in University and elsewhere, it was the demands for speed, accuracy and flexibility in making statistical computations which led to our adoption of Hollerith equipment. The flexibility of the cable plug board is particularly necessary for intercorrelation computations and it was chiefly this advantage which had the final vote in the adoption of Hollerith vs. competing devices, all of which were carefully investigated previous to the installation of equipment. This investigation was perhaps more adequate than ordinarily is the case, in view of the fact that our research office has been busy for over ten years devising a computational type of statistics into which fit most admirably the possible tabulating machine operations, as will be shown in the footnote of a later page.

Before considering in detail the title assigned it may be worth the while to outline briefly some of the activities of our area and their bearing on our use of Hollerith equipment. The writer and Dr. Harold A. Edgerton, with assistants and stenographers comprise one of the five areas, called statistics and college personnel, of the Department of Psychology at Ohio State University. Besides the usual teaching duties and the direction of graduate students, the area is responsible for the local administration of the university intelligence tests to upward of five thousand entrants annually and the researches thereon. For the past five years the writer also has been chairman of the departmental committee on selection of personnel, which has worked out a plan for selection of departmental personnel below the rank of assistant professor, with beneficial effect on the improvement of departmental appointments to the "temporary staff." For the past nine years he has been chairman of the Committee on Intelligence Tests for Entrance of the Ohio College Association. Some nine years ago this committee began a personnel program in the Ohio Colleges by urging the uniform adoption of an intelligence test by the member colleges. Shortly some fifty colleges in the state were giving the tests. Finally the number outside the state surpassed the number in the state. Soon it was seen that a selection

program was too narrow a conception of the entrance problem. It was seen that a guidance program in the secondary schools was a minimal essential. So some five years ago a state-wide testing program of high school seniors was begun. With thousands of test scores available where hundreds existed before, it became obvious that if we were to be able to derive even a fraction of the potential value from the mass of statistics being secured in all these fields some more efficient method of utilizing the accumulating results must be found.

The Hollerith machines were procured by the cooperative rental of a number of departments, and accordingly were used almost entirely for research purposes by the personnel of those departments contributing the funds. Graduate students were quick to appreciate the possibilities which had appealed to the departments, namely relief from routine drudgery of research and the freeing of their time for constructive thinking and planning. The Hollerith operator for the first year or more was under the supervision of the writer; and hence all or practically all large scale research projects of the departments concerned were presented to him for suggestions and approval before being set-up for Hollerith operation.

In many cases the results of questionnaires were brought to the machines for analysis. Almost invariably the questionnaire techniques were found to be so faulty as not only to make their subsequent analysis much more costly than necessary but even ineffectual or impossible. Clearly, then, here was a remediable research difficulty. Accordingly, for some little time the writer dropped his own researches and worked up his extensive notes of a decade of research with questionnaires and positive step scores into book form, in a manuscript entitled "Questionnaires, Standard Codes and Hollerith Machines." Everything written on the subject of questionnaires—so far as it could be found—was read, and, if found valuable, was incorporated into the techniques described in the one thousand page typewritten manuscript. In the course of this our own ideas on the subject of questionnaires and Hollerith techniques likewise crystallized into a considerable number of new techniques not elsewhere published. The researches of the faculty utilizing these techniques improved greatly in quality. So did the graduate theses and dissertations of the graduate students using the techniques. Aspects of a general research problem, formerly of thesis calibre, now could easily be "farmed out" to a graduate student for a magazine article. An afternoon's work or a few afternoons' work on the machines often sufficed to do the routine labor of a graduate research which formerly would have been adequate for an M.A. thesis or Ph.D. dissertation. Checking formulae were developed, by means of which it was possible for a research professor to find out in a few minutes time whether a student's entire study was done accurately.* Research findings became available in a short time and were based upon enough cases that one could be reasonably sure of the validity of the conclusions. For example, a student studying some 2,000 high

* For example, see, Toops, Herbert A.—Statistical Checks on the Accuracy of Intercorrelation Computations. Educational Research Bulletin, Vol. 6,, No. 18, 1927, pp. 385-391.
The general proposition of checking computations will be treated in the writer's forthcoming "Computational Statistics." A recalculation of the statistical work reported in the professional magazines reveals many errors and not a few of such magnitude as to be distinctly reprehensible.

school students repeatedly retested on intelligence tests discovered that an annual retest is of sufficient promise in predicting college success to make such retesting advisable. For the next autumn's testing we devised a test which could be scored on the printing press and could be used over and over again simply by replacing the answer envelope. We then asked the high schools to test not only seniors but sophomores and soon we were testing 50,000 annually. All of this was accomplished in but little more than a year's time.

A very effective high school personnel information blank was devised, and it soon became apparent that—with the aid of the machines and the information canned-up in the pupils' Hollerith cards—the schools are a most effective medium for carrying on a social survey of a very worth while sort *provided* the previous questionnaire technique be good. The results of the first preliminary tabulations,* for example, when interpreted in the light of the findings from additional studies, showed some striking facts, notably:

1. The colleges of Ohio could be recruited twice over from high school graduates who are above 40 centile rank in intelligence (that is, from pupils all of whom would rate among the 60 per cent of most intelligent Ohio College Association freshmen), provided means could be found to enlist the attendance of such pupils.
2. There are vast inequalities in educational opportunity of high school pupils. For example, by coding all the occupations of Ohio (census of 1920) into one hundred groups and determining their frequency, it was possible to make a good guess as to how many parents of potential-college-going children in 1929 there were; then by asking the college students (of a given college or group of colleges) their parental occupations—as had been done annually at Ohio State University for 10 years—finally it was possible to make a rough guess as to the relative "support of higher education" by the several occupations or occupational groups.** One occupation on a preliminary sampling, was found to have sent, relatively, some 2000 times as many students to the state university in ten years as had another.
3. There is a great need for guidance in the secondary schools.
4. There are vast intellectual inequalities among the several high schools of the state. These tend to accentuate the divergencies of meanings of scholastic marks and academic credentials furnished the entrance boards of the colleges.

In the autumn of 1933, with the invention of a form of test which has a replaceable answer pad, it was made possible for a school to test all of its freshmen, sophomores, juniors and seniors on a highly valid two-hour intelligence test for 2½¢ per pupil tested for fully scored tests. As a result we shall have for the year 1933-34 upwards of 100,000 intelligence and personnel information records on Ohio high school pupils to be punched into Hollerith cards.

* H. S. Bulletin No. 4—Report on the Annual State-Wide Intelligence Testing Program of Seniors, Oct. 7, 1930. Ohio College Association Committee on Intelligence Tests for Entrance, Herbert A. Toops, Chairman, Ohio State University, Columbus, 31 pp.

** The Ohio frequency of an occupation divided by the Ohio State University frequency, roughly is an "index of how many Ohio families it takes to send Ohio State University a freshman in a ten year period."

Just one example of the vast potentialities for research of such records may be revealed by a certain pair of questions.
(See Nos. 31 and 32 of Figure 144.):

"Check the proper one of the following statements:

I *am not* a twin ☐ 1
I *am* a twin ☐ 2

and the name of my twin brother or sister is: _____

Name of your twin brother or sister. (If you have no living twin brother or sister write "none" here.)

As a result of this question we locate annually several hundred pairs of twins. Now to the student of education or of genetics, twins—particularly those of equal educational status—are pearls of great price. It is clear then that we may readily conduct *extensive* and worth-while social researches through school children and also locate a goodly number of individuals of special characteristics or experience for further *intensive* study and experimentation. We cannot experiment with human beings in many of the most important realms of science, but Nature performs experiments innumerable which we may locate, if we will, and then study as intensively as we please.

Everyone, except a few physically incapacitated, goes through the school portals at one time or another. The human "specifics" noted there must be caught, recorded, and utilized for the improvement of education and for the advancement of pure research.

We need accordingly to collect such "experience" as broadly as we may. This argues both for uniformity and extensity of collection of such information. The colleges of Ohio each ask a varied list of questions on their application blanks. The thought arises, why not combine the good, the valuable, the essential questions of all the forms—and of other good forms everywhere—into one longer application blank; perfect the questions; and then ask every senior in the high schools to fill out such a blank, regardless of college intentions? Such a uniform entrance blank was tentatively adopted by the Ohio College Association at its meeting in the spring of 1934 and it is the hope that a Hollerith card based upon the data therein can be punched up hereafter for every high school senior. Then by a follow-up in the Ohio Colleges some months (or years) later one may note pretty exactly the effect of each "trait" on the probability of college-going, and upon college success, measured both in marks and in persistence.

In the course of these studies it became obvious that we had need for a measure of socio-economic status of each pupil. This was secured by analyzing, by the partial regression equation method, the significance for income of the possession or non-possession, other things being equal, of each of some forty family "possessions" in the case of the carefully-and-personally-investigated families of 305 successive Columbus-born babies, therefore, a random selection of the baby-bearing portion of our population. The resulting questions appear as Part III of the "Further Educational Intentions Blank" (page 185). The "yes" answer of each question has a different credit or score assigned to it,

as does each different house rent figure and each different number of rooms in the house—or, in general, it may be stated that each category of answer to each question has a different and specific credit of probable-salary-increment assigned. By adding up these credits or probable salary increments—obtained from asking the pupil such questions as: Is your home heated by a furnace? Does it have a bathroom? Does it have a vacuum cleaner?—we arrive finally at an index of his family's income. This estimated income is probably more accurate than the pupil's own estimate even if he were willing to give it. The thought was that if a teacher, acting as adviser to a high school pupil, were to learn as early as the pupil's freshman year his intelligence, probable high school scholarship and probable college-going intentions and financial possibilities, he could begin earlier to plan with the capable but needy pupil a means of making college attendance possible, with the hope that perhaps ultimately a national scholarship policy might come to prevail.

In all such problems as the above all the possible intercorrelations of n variables need to be computed. This the Hollerith equipment does with unbelievable speed and with checked accuracy.* One of our best records, perhaps, was made in a study of the intercorrelations of some 60 variables—ratings on a 5-point rating scale of 15 traits rated by high school principal, teacher, minister and college alumnus—for some 250 college entrants. There were upwards of 1800 correlations to be solved, each twice over independently for a check. The machine work for these was done in two day's time. When the work was completed and the final check was applied, we knew that every single computation was correct. By hand methods this job would have taken weeks of work of two well-trained clerks.

In the process of revising and improving the intelligence tests above referred to, we conceived each question of a test or examination to be in itself a test, with but two scores: a score of zero if the question were answered incorrectly and a score of one if answered correctly. Accordingly questions, or items, have all the numerical and statistical possibilities of tests. Among 100 items of a test, there are, for example, some 4950 possible intercorrelations. By a process of multiple punching the Hollerith cards, and using a counting-sorting-printer of 3 rolls, some potential 720-man power was attained in determining the four-fold frequencies involved in the body—as well as margins—of tables similar to the following:

		Item 1		
		Fail	Pass	Total
Item 2	Pass	29	89	118
	Fail	63	14	77
	Total	92	103	195

With a larger number, than 195, of persons tested, so that the actual attainment in the use of the machines would approximate closely the theoretical pos-

* Toops, Herbert A.—Questionnaires, Standard Codes and Hollerith Machines. Chapter 11, "Special Applications of Hollerith Equipment" to be published soon.

sible attainment, to run such an outfit for one day would be the equivalent of having a clerk make tally marks in tables such as the above for two years without holidays, vacations or Sunday rest periods. And, if the amount of work justified, there is no essential reason why one should not employ eighty counting-printing rolls, instead of three, with the result that one day's operation of the outfit would yield more than a life's labor of a clerk even though he outlived the traditional three score and ten years and never asked for even a single half-day's holiday. Such speculations are so stimulating that we became interested in determining what is the upper limit of capacity of a single Hollerith card for research purposes.

It had been known for some time, for example, that most statistical variables can be coded into not less than twelve classes without appreciable distortion of the facts; and that the face values (point midway between the two extremes of a statistical class) of these classes may then be coded in a series of positive coded steps, thus:*

TRANSMUTATION TABLE

X_F	X'
Class	Coded Step
60-62	0
63-65	1
66-68	2
69-71	3
72-74	4
75-77	5
78-80	6
81-83	7
84-86	8
87-89	9
90-92	10
93-95	11
96-98	12
99-101	13

* For such a table it is readily possible to obtain a formula stating the face-values of the classes X_F's as a function of the step-scores, X''s. The equation for the above table, for example is:

$$X_F = 3X' + 61$$

Thus step 7, by reference to the classes above, is seen to have the face-value 82 and by formula $3(7)+61=82$; and step 10 the face-value 91, the computation being: $3(10)+61=91$, or a one-to-one correspondence between step-scores and face-values of the corresponding classes. Having this equation, it is possible to derive to order equations for means and standard deviations, for example, involving these X' scores, the scores preferably to be punched into a Hollerith card for intercorrelation solving purposes, and then from the resulting Hollerith summations and computations determine the corresponding (corrected) means, standard deviations, and the like.

If the lowest score of each class of the above table is a multiple of the class interval, as here, where the class interval is 3, one may readily transmute the crude scores to step-scores for Hollerith punching by a mental rule: e.g., "Divide the score by 3; throw away any decimals resulting; subtract 20 from the result. The final remainder is X', the transmuted score." Thus, to transmute 80: $80/3 = 26$, and $26 - 20 = 6$. The same result, of course, may be had by referring to the transmutation table; where a score of 80 is seen to be a coded score of 6. After verification the transmuted score, 6, may be punched into the Hollerith card in lieu of the original score, 80. The thus-coded scores yield the same means, standard deviations, and the like as the original scores do when grouped by the classes of the above table.

The equations, when employed for statistical purposes, give one a command over the Hollerith operations that is well-nigh perfect. It is to such equations that reference has been made in the opening paragraph of this chapter. All of the customary formulæ commonly used in psychological testing and in personnel and educational research work will be treated from this positive step, or transmuted score, basis, or viewpoint, in the author's forthcoming text entitled "Computational Statistics."

By a further coding of the once-coded steps it is possible to recode and punch all coded scores, 0 to 15, inclusive, into a series of four successive multiple-punched positions of a column of the Hollerith card.* It is clear, then, that three variables, *each of practically unlimited extent as to original scores involved,* may be punched by this multiple-coding scheme into one column (12 positions) of the card; and that, consequently, some 240 many-categoried variables belonging to any one individual may be punched into an 80-column Hollerith card.

This application is based upon the concept that any score or coded score, X′, can be expressed as:

$$X' = a2^0 + b2^1 + c2^2 + d2^3 + \cdots\cdots$$

where a, b, c, and d are each limited to two values, O and 1. Thus an X′ of 13 can be represented as:

$$X' = 1.2^0 + 0.2^1 + 1.2^2 + 1.2^3 = 1 + 0 + 4 + 8.$$

Accordingly, with the formula available, all the usual statistical formulae involving coded scores (X′'s) may be rederived in terms of this new concept.

By this method all correlation tables degenerate into four-fold by four-fold contingency tables. The saving in time in the solution of the correlation coefficients, means, and standard deviations, well may be imagined. And since this table of only 16 compartments is based on powers of 2, the computations are still further simplified.

The above is mentioned to emphasize the point that Hollerith equipment has a very beneficial effect upon the thinking of a research worker. Specifically, the machines act mechanically, blindly, and unintelligently—although with an accuracy, speed, and seeming intelligence *for those operations for which they are set,* which, to the casual observer, appears superhuman, as indeed it is in fact. Accordingly all possible complications and all contingencies in the treatment of the data must be foreseen and be provided for, preferably even before the printing of the first questionnaire of an investigation. One must decide in advance of printing his questionnaires what tables he is going to compile, which are necessary and which unnecessary, what to do with the answers to individual questions of those persons *who "do not answer"*; what to do with those answers of persons to a particular question for whom some special consideration applies so that they *are "unable to reply"*—as, for example, a student's father is dead so that he cannot give his age (see question 22 of Fig. 144, page 185; what classifications are appropriate for each variable; and what provision needs to be made for precoded categories on the questionnaire (see questions 9 and 10) to be checked by the respondent. The necessity of planning for all such has, then, a very beneficial effect upon the thinking of the research worker by expanding his horizon as to the possibilities of analysis, for it is axiomatic that any analysis capable of being done from a punched card can be done very readily and almost effortlessly with the various general and specialized machines now available if the Hollerith card be de-

* Royer, Elmer B., and Toops, Herbert A.—The Statistics of Geometrically Coded Scores. Journal of the American Statistical Association, Vol. 28, No. 182, 1933, pp. 192-198.

STATEMENT OF FURTHER EDUCATIONAL INTENTIONS

Directions for filling out this page:

Please answer carefully *every* question below. This will form a portion of your permanent school records, so *please write legibly.* The examiner will read the questions. Follow the examiner; write in your answer as soon as the examiner finishes reading the question; do not get behind, or go ahead of, the examiner. Do not leave any question blank; *every question must have some answer written in. Please write legibly.*

Please notice that you are to *copy exactly* each of your answers at the right of the perforation. The right hand portion will be torn off *later,* so *be sure to copy your answers* exactly, *and do not write across the perforation.*

Time required: Approximately 12 minutes.

Serial Number on Intelligence Test Blank [ ]
(You will fill this in *after* completing the Intelligence test

Intelligence Test Form.....

Test	No. Right		Centile Rank
1		*Freshman* Norms	
2		*Sophomore* Norms	
3		*Junior* Norms	
Sum		*Senior* Norms	

1933-34 [1]

1. High School Identification Number (The examiner will dictate this number for copying by all.) — Co. No. [2-3] H. S. No. [4-5]

2. The Name and Address of my high school is — *Name* of High School or academy; *City* in which High School is located; *County* in which High School is located; *State* in which High School is located

3. My Class Rank is — Check "X" the Proper Class: Freshman ☐9, Sophomore ☐0, Junior ☐1, Senior ☐2, Graduate ☐3, Special ☐4 [16]

ABCDEFGHIJKLMNOPQRSTUVWXYZ

4. My Last or Family Name is (Print all letters in capitals. See alphabet above.) — *My last or Family Name* [17-18-19] [20-21-22]

5. My First and Middle Names are (Print all letters in capitals. See alphabet above.) — *My First Name*; *My Middle Name* [23-24-25]

6. My permanent home address is (Address where mail will always reach you) — Street and Number; City; County; State

7. Check "X" the appropriate one of the two following statements: (Include only phones in the house in which you live.) — Our home *does not* have a *telephone* ☐1; Our home *does* have a *telephone* ☐2 [26]

8. Our Home Telephone is — *Home* phone number. If you have no phone at home, write "No Phone" (1) here.

9. My high school course or curriculum is (If you don't know, ask the examiner for help.) — Check "X" the proper curriculum: General Academic ☐1, College Preparatory ☐2, Commercial ☐3, Technical ☐4, Vocational Agriculture ☐5, Vocational Home Economics ☐6 [27]

PART II. Questions About Myself and My Family

10. My Sex and Color are — Check "X" the proper combination of *sex* and *color.* (Check only one of the ten combinations.)

female-white	☐0	male-white	☐5
female-black (negro)	☐1	male-black (negro)	☐6
female-brown	☐2	male-brown	☐7
female-red (Indian)	☐3	male-red (Indian)	☐8
female-yellow (Chinese-Japanese)	☐4	male-yellow (Chinese-Japanese)	☐9

[28]

11. Marital condition: I am — Single ☐1, Married ☐2, Widowed ☐3, Separated ☐4, Divorced ☐5 [29]

12. My ancestry is chiefly — German, Italian, Jewish, Russian, etc.

13. I ..... a member of a church

14. If a church member, the church to which I belong is — "am" or "am not"; Name of *denomination* to which you belong. (If not a member, write "not a member" (99) here.) [30-31]

15. The date of my birth is — Birthdate: Month, day and year *in which you were born*

16. My age at my *last* birthday was — Age at *last* birthday. [32-37]

17. My birthplace is — Birthplace: City, County, State

18. The country in which *I* was born is — *My* Birthplace: Name of Country

19. The country in which my *father* was born is — *Father's* Birthplace: Name of Country

20. The country in which my *mother* was born is — *Mother's* Birthplace: Name of Country [38]

Serial Number on Intelligence Test Blank [ ]
After answering on the line to the left of the perforation, copy exactly your previous answer in the corresponding spaces to the right of the perforation.

Intelligence Test Form.....

Test	No. Right		Centile Rank
1		*Freshman* Norms	
2		*Sophomore* Norms	
3		*Junior* Norms	
Sum		*Senior* Norms	

1933-34 [1]

Co. No. [2-3] H. S. No. [4-5]

Name of High School or academy; *City* in which High School is located; *County* in which High School is located; *State* in which High School is located

Check "X" the Proper Class: Freshman ☐9, Sophomore ☐0, Junior ☐1, Senior ☐2, Graduate ☐3, Special ☐4 [16]

[17-18-19] [20-21-22]

My last or Family Name

My First Name; *My Middle Name* [23-24-25]

Street and Number; City; County; State

Our home *does not* have a *telephone* ☐1; Our home *does* have a *telephone* ☐2 [26]

Home phone number. If you have no phone at home, write "No Phone" (1) here.

Check "X" the proper curriculum: General Academic ☐1, College Preparatory ☐2, Commercial ☐3, Technical ☐4, Vocational Agriculture ☐5, Vocational Home Economics ☐6 [27]

Check "X" the proper combination of *sex* and *color.* (Check only one of the ten combinations.)

female-white	☐0	male-white	☐5
female-black (negro)	☐1	male-black (negro)	☐6
female-brown	☐2	male-brown	☐7
female-red (Indian)	☐3	male-red (Indian)	☐8
female-yellow (Chinese-Japanese)	☐4	male-yellow (Chinese-Japanese)	☐9

[28]

Single ☐1, Married ☐2, Widowed ☐3, Separated ☐4, Divorced ☐5 [29]

German, Italian, Jewish, Russian, etc.

.....a member of a church

"am" or "am not"

Name of *denomination* to which you belong. (If not a member, write "not a member" (99) here.) [30-31]

Birthdate: Month, day and year *in which you were born*

Age at *last* birthday. [32-37]

Birthplace: City, County, State

My Birthplace: Name of Country

Father's Birthplace: Name of Country

Mother's Birthplace: Name of Country [38]

FIG. 143—Front

Nº 65381

21. The occupation, trade or business of my *father* is

Father's Occupation: Farmer, Carpenter, etc. [39-40]
(If he is dead or retired, give his former occupation.)

22. and *he* is

.....years of age [41-42]
(If you don't know, estimate it, and put a "?" after it. If your father is dead, write "dead" here.)

23. The occupation, trade or business of my *mother* is

Mother's Occupation: Housewife, Stenographer, Nurse, etc. (If she is dead or retired, give her former occupation.) [43-44]

24. and *she* is

.....years of age [45-46]
(If you don't know, estimate it, and put a "?" after it. If your mother is dead, write "dead" here.)

25. I

decided on
.....my occupation
"Have not" or "have" or life work

26. The occupation, trade or business which *I* expect to go into for a life work is

Name of *your* expected occupation, trade or business. (If you have not decided, write "Have not decided" here.) [47-48]

27. I have

.....living *older brothers* [49]
Give No. of *older brothers*, or write "none."

28. I have

.....living *older sisters*
Give No. of *older sisters*, or write "none."

29. I have

.....living *younger brothers* [50]
Give No. of *younger brothers*, or write "none."

30. I have

.....living *younger sisters*
Give No. of *younger sisters* or write "none."

31. Check the proper one of the following statements:

I *am not* a twin ☐1
I *am* a twin ☐2 [51]

32. and the name of my twin brother or sister is

Name of your *twin* brother or sister. (If you have no living twin brother or sister, write "none" here) [52]

33. I am writing here the names and class ranks (freshmen, sophomore, etc.) of any brothers or sisters now attending high school.

Names and *class ranks* of all brothers or sisters attending high school. Example: Mary Jane Jones, "Senior." (If you have *none in high school*, write "none" here.)

34. I

.....expect to go to college [53-54]
"Do not" or "do"

35. and the college which probably I will attend is

Name of college or university which probably you will attend. (If you do not intend to go, write "Will not go" (99) here.)

36. If an average four-year university course costs $2500, is your family *financially able* to bear the cost of such a course for you? (Note: This is about $625 per year for *each* of four successive years.)

Answer "No" or "Yes" [55]

37. If an average four-year university course costs $2500, is your family *willing* to bear the entire cost of such a course for you?

Answer "No" or "Yes"

PART III. *Questions About My Home*

38. My folks

.....our home [6]
"rent" or "own"

39. The *house rent* on our home is

.....dollars a month
Monthly rent. If your folks own your home, write "own our home" here and if you know how much a month it would rent for, please give that too.

40. Our home has

.....*rooms* in it [7]
Give the number of *rooms* in your home. Count bathroom as a room but do not count a hall, basement or attic as a room.

41. Our home

.....heated by a *furnace* [8]
"Is not" or "is"

42. and

.....have a *bathroom* [9]
"Does not" or "does"

43. Our family hires about

.....days of *housework* done every week
Give number of days of housework hired every week; or write "none." [10]

44. The *family washing* is usually done

"at home" (1) or "at a laundry" or "at a washerwoman's" (2) [11]

45. The *family ironing* is usually done

"at home" (1) or "at laundry" or "at washerwoman's" (2) [12]

46. Our family

.....have an *electric* or *gas-oline* washing machine [13]
"does not" (1) or "does" (2)

47. Our family

.....have a *vacuum cleaner* [14]
"does not" (1) or "does" (2)

48. Our family

.....have a *radio* [15]
"does not" (1) or "does" (2)

49. and I listen-in about

.....hours ever week
Give number of hours weekly or write "none"

50. During the last seven days I went to the *movies*

.....times
Give number of times you attended the movies in the last seven days; or write "none."

51. Today's date is

Month Day Year

52. My signature

.....

REMAIN QUIETLY IN YOUR SEAT UNTIL THE EXAMINER GIVES YOU FURTHER DIRECTIONS

Father's Occupation: Farmer, Carpenter, etc. [39-40]
(If he is dead or retired, give his former occupation.)

.....years of age [41-42]
(If you don't know, estimate it, and put a "?" after it. If your father is dead, write "dead" here.)

Mother's Occupation: Housewife, Stenographer, Nurse, etc. (If she is dead or retired, give her former occupation.) [43-44]

.....years of age [45-46]
(If you don't know, estimate it, and put a "?" after it. If your mother is dead, write "dead" here.)

decided on
.....my occupation
"Have not" or "have" or life work

Name of *your* expected occupation, trade or business. (If you have not decided, write "Have not decided" here.) [47-48]

.....living *older brothers* [49]
Give No. of *older brothers*, or write "none."

.....living *older sisters*
Give No. of *older sisters*, or write "none."

.....living *younger brothers* [50]
Give No. of *younger brothers*, or write "none."

.....living *younger sisters*
Give No. of *younger sisters* or write "none."

I *am not* a twin ☐1
I *am* a twin ☐2 [51]

Name of your *twin* brother or sister. (If you have no living twin brother or sister, write "none" here) [52]

Names and *class ranks* of all brothers or sisters attending high school. Example: Mary Jane Jones, "Senior." (If you have *none in high school*, write "none" here.)

.....expect to go to college [53-54]
"Do not" or "do"

Name of college or university which probably you will attend. (If you do not intend to go, write "Will not go" (99) here.)

Answer "No" or "Yes" [55]

Answer "No" or "Yes"

.....our home [6]
"rent" or "own"

.....dollars a month
Monthly rent. If your folks own your home, write "own our home" here and if you know how much a month it would rent for, please give that too.

.....*rooms* in it [7]
Give the number of *rooms* in your home. Count bathroom as a room but do not count a hall, basement or attic as a room.

.....heated by a *furnace* [8]
"Is not" or "is"

.....have a *bathroom* [9]
"Does not" or "does"

.....days of *housework* done every week
Give number of days of housework hired every week; or write "none." [10]

"at home" (1) or "at a laundry" or "at a washerwoman's" (2) [11]

"at home" (1) or "at laundry" or "at washerwoman's" (2) [12]

.....have an *electric* or *gas-oline* washing machine [13]
"does not" (1) or "does" (2)

.....have a *vacuum cleaner* [14]
"does not" (1) or "does" (2)

.....have a *radio* [15]
"does not" (1) or "does" (2)

.....hours ever week
Give number of hours weekly or write "none"

.....times
Give number of times you attended the movies in the last seven days; or write "none."

Month Day Year

.....

DO *NOT* TEAR OFF THIS STUB

FIG. 144—Reverse (Tumble printed)

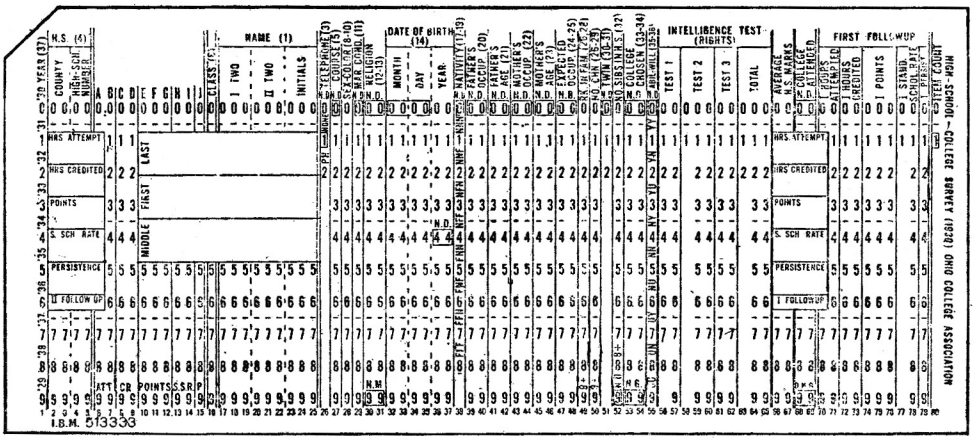

FIG. 145

signed with the particular analysis in view. It therefore follows that whatever is good technique for machine analysis will be even more efficient technique when hand methods of tabulation are employed. Paradoxically, then, training in tabulating-machine techniques is one of the best for acquiring research competence for work in a research bureau where these machines are not available.

As an example of our questionnaire technique and accompanying Hollerith card, we present Figs. 143 to 145 incl.

The Further Educational Intentions Questionnaire has been filled out in 1933-34 by upwards of 100,000 high-school pupils in one thousand high schools under the supervision of as many teachers; and yet almost every blank is filled out perfectly. Note how footnotes anticipate all the unusual classes of pupils and tell each such pupil specifically what to do at the very time he wants to know; how a positive response is required to every question even though the pupil's reply be negative in intent—with the result that there is no guessing on the part of the card puncher as to what any pupil meant by his reply to any question; how the answers align in a column so that no question is overlooked by the pupil in writing out his answers; how the answers are precoded, wherever the possible list of answers is few in number, with little code numbers to assist the memory of the Hollerith puncher when punching the data, so that memorization of codes is unnecessary; how bold-faced boxes are provided for recording by a coder the coded score for multiple-category answers such as religion, occupation, and college of expected attendance—an expert in coding the answers in any one field of coding, e.g. occupations, being employed to score all papers on any one such question previous to punching; how, when there are cross-check questions involved in a coded score, these boxes extend the height of the two or three questions bearing on the score in question; how the Hollerith card columns into which a given item of information is to be punched is indicated on the blank (in brackets) after each answer space, thus facilitating both the punching and the visual inspection or checking of any punched card against the original data medium; and how each

answer is filled out in duplicate by the pupil so that, after severing the stub at the perforation the original questions and answers may be left at the school, while the stub containing the simple answers themselves—involving, therefore, a much smaller transportation and storage problem—are sent to central headquarters for punching and can be held readily in the left hand for this purpose.

The accompanying Hollerith card, it will be noted, provides for recording not only all this information but also intelligence-test scores and many additional college follow-up data. From such cards, if filled out annually for all of 300,000 high-school pupils of the state as they pass through high school and college, one could secure a most adequate picture of the future adult talent of our state.

A Pre-Coded State Teachers Report

This same possibility of doing-the-whole-job is illustrated in a study by similar questionnaire and specially printed Hollerith card of the 46,000 teachers of the state. See Figs. 146 to 148. The precoded questionnaire replaced the customary teacher's annual report to the state superintendent of schools. It asked a dozen more questions than ordinarily are asked of the teachers. Accordingly, it furnished data for making a great host of studies. As one very concrete example of the usefulness of collecting all the data at one time, this questionnaire forestalled at least two lengthy questionnaires which were being prepared for distribution to the teaching profession of the state. The information desired by these people was contained in the punched Hollerith cards—and much more besides, if they should discover that additional enlightenment on their problem could be had by an extra tabulation or two of items which they had not contemplated including in their questionnaires.

The questionnaire was written in a terrific hurry—as unfortunately are too many questionnaires—so that several technical errors crept in, which we now know should have been avoided. We could certainly build a better questionnaire now. However, there are a number of points worthy of special mention, perhaps:

1. The questionnaire was printed from an electrotype so that in case of shortage it could be duplicated quickly and absolutely correctly.
2. The Hollerith card, into which the returned data were to be punched was designed before the questionnaire was set up in type. Accordingly, the codes for punching the returns were printed on the questionnaire (saving enormous coding bills as well as errors in punching) together with the column numbers of the Hollerith cards into which a given reply was to be punched.
3. The routing of the blank, the definitions of persons obligated to reply, the period covered, are all carefully given in the questionnaire.
4. The questionnaire was printed on four pages with fold at the top so that it could be inserted readily in the typewriter for answering.

Form 4—100M—March, 1930. Section 7784, General Code.

STATE OF OHIO
DEPARTMENT OF EDUCATION
COLUMBUS

Annual Report to the Superintendent of Schools

(Two copies of this report are to be sent to the county, city, or exempted village superintendent.)

For the year beginning September, 1929, and ending June, 1930.

PART I.

To be filled out in duplicate by all full time teachers, part time teachers, principals, assistant principals, supervisors, assistant supervisors, superintendents, and assistant superintendents, in short, by all who must hold a teaching certificate in order to qualify for their positions.

NOTE:—All of the questions which are asked in this report are either required by the national government or are necessary for reasons of fundamental importance. None of them are trivial. You will contribute in an important manner to the cause of education by filling out the answers conscientiously throughout this report. Disregard figures in parentheses. These are code numbers to be used as an aid in tabulating the information in the report.

1. Name of county **1929-1930** (1)

Name of county (2)

2. Name of city or exempted village .....

Name of City (1) or exempted village (3)

3. Name of school (school building) .....

Name of school (school building) (4)

Please do not write in these boxes

Kind (2) | System (3-4) | School No. (5-7)

4. Name of teacher .....

(Please write legibly.) Last First Middle

5. Sex ..... Answer "male" or "female" (1-2) (3-4)

6. Color ..... Answer "white" or "colored" (1-3) (3-4) (17)

7. Date of birth ..... Month Day Year (18-23)
(It is very important that the month, day and year of birth all be given.)

8. The country in which *I* was born is .....

The country in which *my father* was born is .....

The country in which *my mother* was born is ..... (24)

Please do not write in these boxes.

I-two(8-10) | II-two(11-13) | Init.(14-16) | S-C (17) | Month (18-19) | Day (20-21) | Year (22-23) | Nat. (24)

9. Marital condition; check (X): Single .....(1) ☐
Married .....(2) ☐
Widowed .....(3) ☐
Separated .....(4) ☐
Divorced .....(5) ☐ (25)

10. Grade or grades taught by me .....
Grade or grades taught

11. Consider the time per week which you devote to teaching, supervision of teaching or of practice-teaching, administration, other miscellaneous activities, or any combination of these. In column A write the percent of this time which you spend in teaching in each of the nine types of schools.

If you supervise teaching or practice-teaching, write in column B the per cent of your time which you devote to supervision in each of the nine types of schools.

If you do not teach, all of the per cents in column A will be 0; if you do not supervise, all of the per cents in column B will be 0.

If you teach only, the per cents in column A will add up to 100; if you supervise only, the per cents in column B will total 100.

If you devote full time to teaching in the kindergarten, you will write 100 in column A opposite "kindergarten."

If you devote one-half of your time to teaching in the kindergarten and one-half of your time to teaching in the elementary school, write 50 in column A opposite "kindergarten" and 50 in the same column opposite "elementary school".

If you spend part time in teaching, part time in supervision, part time in administration, and part time in miscellaneous activities, you will make appropriate entries in all of the columns.

In every case the sum of all your entries in all columns combined will be 100.

Types of Schools:	Per cent of a Typical Week Devoted to A Teaching	B Supervision	C Administration	D Miscellaneous	Total
a. Kindergarten .....(1)					*
b. Elementary—(Including schools, if any, with departmentalized 7th and 8th grades which are not recognized as junior high schools by the State Department of Education) .....(2)					*
c. Separately organized junior high schools, grades 7, 8 and 9. (See Sec. 7652, G. C.).....(3)					*
d. Separately organized senior high school, grades 10, 11 and 12....(4)					*
e. Junior-Senior (6-year) high school under one organization, grades 7 to 12 inclusive.....(5)					*
f. Regular high school of 4 years, grades 9 to 12 inclusive .....(6)					*
g. Second grade high schools, grades 9, 10 and 11 .....(7)					*
h. Third grade high school, grades 10 and 11.....(8)					*
i. Ungraded classes of exceptional children.....(9)					*
Total	**	**	**	**	100
	(26)	(27)			(28-43)

Add the rows and also the columns. Be sure that they check.
*The sum of the per cents recorded in the nine boxes marked with a single asterisk (*) must total 100.
**The sum of the per cents recorded in the four boxes marked with double asterisks (**) must total 100

12. If you do NOT either supervise or teach any classes in the Junior or Senior High School, check (X) here ☐

13. Question 13 is to be answered only by those who teach or supervise for at least part time in *Junior high school, high school, or both.*

Teachers—all those who teach for at least part time, (including those teachers, supervisors of special subjects, principals and superintendents who teach) will check (X) in column A the subjects taught.

Supervisors of special subjects—will check (X) in column B the subjects which they supervise.

High school principals and superintendents will indicate their supervision by checking the last item, "All subjects," in column B. They will also indicate the subjects taught, if any, by checking the appropriate subjects in column A. Those who do not supervise at all will leave column B blank. Those who do not teach at all will leave column A blank.

Subjects	A Teaching	B Supervision
Agriculture .....(01)		
Algebra .....(02)		
Arithmetic .....(03)		
Art .....(04)		
Biology .....(05)		
Chemistry .....(06)		
Civics .....(07)		
Commercial Subjects .....(08)		
English .....(09)		
French .....(10)		
General Science .....(11)		
Geography .....(12)		
Geometry .....(13)		
German .....(14)		
Health and Physical Education.....(15)		
History .....(16)		
Home Economics .....(17)		
Industrial Arts .....(18)		
Latin .....(19)		
Manual Training .....(20)		
Music .....(22)		
Physics .....(23)		
Sociology .....(24)		
Spanish .....(25)		
Other subjects, (please specify).....		
All subjects .....(99)	******** ********	
	(44-55)	(56-97)

14. What is the actual total amount of money received as regular school salary* in Ohio by you this year (1929-30), including the money paid into the Retirement Fund by the clerk of the Board of Education? ..... $.....
(98-61)

(*Note: This salary refers to the amount receivable for service in the *regular session* whether paid in 8, 9, 10, 11 or 12 monthly installments; and does not include summer session or night school salary. Do not count salary for substitute teaching if you were not on a regular monthly salary.)

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FIG. 146

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15. How many months have you been regularly employed in your *present position** this school year (1929-30)?.....
Months in *present* position (1929-30)

*See footnote to question 16.

16. How many months in all have you been employed in school work* *in Ohio this school year* (1929-30)?.....
Months in all positions in Ohio (1929-30) (62)

(*Note: The answers to questions 15 and 16 will be identical for all those who have occupied one position for the entire school year; the answers will be different for those who have occupied two or more positions in Ohio, either in the same or different schools, during the school year. Do not count substitute teaching for which you were not on a regular monthly salary.)

16a. How many months, if any, have you been employed in school work *OUTSIDE* Ohio this school year (1929-30)?.....
Months in positions OUTSIDE OHIO (1929-30)

17. Including the amount paid to the Retirement Fund, what was the actual total amount of school salary received by you during *last* year, (1928-29)?..... $.....
(See note under question 14.) (63-64)

18. How many months in all were you regularly* employed in school work *last* school year, (1928-29)?.....
Months in all employed (1928-29)

(*Note: Do not count substitute teaching for which you were not on a regular monthly salary.)

19. If you do *NOT* hold an elementary certificate valid in Ohio, check (X) here..... ☐

20. Question 20 is to be answered by all those who now hold certificates valid in Ohio for teaching in *elementary grades or kindergarten.* Indicate with a check (X) each type of certificate which you now hold.

Kinds of certificates:

Local Elementary	(1)	
State four-year provisional elementary or kindergarten	(2)	
State five or eight year elementary	(3)	
State life elementary	(4)	

(65)

21. If you do *NOT* hold a certificate valid for teaching in an Ohio public *HIGH* school, check (X) here..... ☐

22. Question 22 is to be answered by all those who hold high school, special, or vocational certificates, which are valid in Ohio. Indicate with a check (X) each type of certificate which you now hold.

Kinds of certificates:

Local special	(1)	
Local high school	(2)	
State four-year provisional special	(3)	
State four-year provisional high school	(4)	
State five or eight year special	(5)	
State five or eight year high school	(6)	
State life special or high school	(7)	
Any other type of special, vocational or high school certificate valid in Ohio	(8)	

(66-67)

23. Check (X) in the following list the item which best represents the number of years of experience you have had in school work in all schools, including this year.

One year or less	(x)	
More than one year but less than three	(0)	
Three years but less than four	(1)	
Four years but less than five	(2)	
Five years but less than ten	(3)	
Ten years but less than fifteen	(4)	
Fifteen years but less than twenty	(5)	
Twenty years but less than twenty-five	(6)	
Twenty-five years but less than thirty	(7)	
Thirty years but less than thirty-five	(8)	
Thirty-five years and over	(9)	

(68)

24. Check (X) in the following list the item which best represents the number of years of experience, including this year, which you have had in school work in *the school district in which you are now employed.*
(A school district is the area under the control of a local board of education.)

One year or less	(x)	
More than one year but less than three	(0)	
Three years but less than four	(1)	
Four years but less than five	(2)	
Five years but less than ten	(3)	
Ten years but less than fifteen	(4)	
Fifteen years but less than twenty	(5)	
Twenty years but less than twenty-five	(6)	
Twenty-five years but less than thirty	(7)	
Thirty years but less than thirty-five	(8)	
Thirty-five years and over	(9)	

(69)

25. In the following list check (X) the one item which best represents the highest level of your education at present.

Did not go to high school	(1)	
Attended high school but did not graduate from a four-year high school	(2)	
Graduate of a four-year high school	(3)	
Less than one year (36 weeks) of college, university, or normal school training	(4)	
One year (36 weeks) but less than two years (72 weeks) of college, university, or normal school training	(5)	
Two years (72 weeks) but less than three years (108 weeks) of college, university or normal school training	(6)	
Three years (108 weeks) but less than four years (144 weeks) of college, university, or normal school training	(7)	
Four years (144 weeks) or more of college, university, or normal school training, *but without a four-year college degree*	(8)	
Hold a degree from a college, university, normal school, or teachers college	(9)	

(70)

Page 4

26. Question 26 is to be answered by *all who hold a degree* (or professional diploma) *from a college, university, normal school, or teachers college.* Check (X) each diploma and degree which you now hold.

Diploma from one-year normal school course in elementary education	(0)	
Diploma from a two-year course in elementary education	(1)	
Diploma from a two-year course in kindergarten-primary training	(2)	
Diploma from a three-year course in elementary education	(3)	
Diploma from a three-year course in any special subject (music, art, etc.)	(4)	
Any four-year college degree (i. e., B. A., B. S., B. S. in Education, Ph. B., etc)	(5)	
Master's Degree (M. A., M. E., M. S., etc.)	(6)	
Doctor of Philosophy or Doctor of Education Degree	(7)	
Any general type of diploma or degree not listed above	(8)	

(71)

(If you check (8), write name of diploma or degree here)

.....

27. Write the name of the college, university, normal school, or teachers' college in which you took all or most of your teacher training work. .....
Name of institution or college (72-73)

27a. Address of above institution.....
City and State.

28. Question 28 is to be answered only by those *who have had four or more years of college or university training,* either with or without receiving a degree. In column A check (X) the subject in which you majored. In column B check the subject of your first minor. In column C check the subject of your second minor, (if any). ***Make only one check in each column.***

	(01)	(04)	(05)	(06)	(08)	(09)	(10)	(12)	(14)	(15)	(16)	(17)	(18)	(19)	(21)	(22)	(23)	(24)	(25)
	Agriculture	Art	Biology	Chemistry	Commercial subjects	English	French	Geography	German	Health and Physical Education	History	Home Economics	Industrial Arts, including manual training	Latin	Mathematics	Music	Physics	Sociology	Spanish
A Major																			
B First Minor																			
C Second Minor																			

Other Subjects, (please specify)—

.....

(74-75) (76-77) (78-79)

Date....., 193....

I hereby certify that this report of matters pertaining to this school has been carefully and accurately made, and is correct to the best of my knowledge and belief.

.....
Teacher.

Received, approved and filed:....., *Superintendent.*

FIG. 147

5. A meaningful number was allotted to each school of the state. This was made up of

5.1 An initial digit (Col. 2 of Hollerith card), the kind of school, defined as follows:

Column Position	
1	City School
2	County (rural) School
3	Exempted Village School

5.2 Two digits giving the system number of the school (Columns 3 and 4 of the Hollerith card). This provided for 100 (since 00 can be utilized) different city systems; 100 county systems [There are 88 counties in Ohio]; and 100 different exempted village systems [There are 55 exempted villages in Ohio].

5.3 Three digits allotted to individual school number within each system (Columns 5-7 of the Hollerith card) thus providing for a maximum of 1,000 schools in any given city, county or exempted village.

Thus at practically no cost in columns on the card we have a number for each of many thousands of schools, and one which enables us to tell from the serial number the kind of school and its location.

If repeating this, we should send these serial numbers in a mimeographed list to each school and ask each teacher to copy the appropriate serial number of her school on her questionnaire.

The school serial number being common to all the reports of a given building, the correct serial number—and also the year of the report, June of 1930 (or zero)—was punched into Hollerith key cards, in advance of the arrival of the returned reports, and then were duplicated by the duplicating punch into the Hollerith cards of all teachers of a given school.

These cards, when the principal's name and address were typed thereon, serve also as an address file of the schools, in all communications with the schools in question.

6. A meaningful code number for each teacher was also established. This consisted of:

6.1 Three digits (Columns 8-10) comprising an exact coding of the first two letters of the teacher's last name.

6.2 Three digits (Columns 11-13) comprising an exact coding of the second two letters of the teacher's last name.

6.3 Three digits (Columns 14-16) comprising an exact coding of the teacher's initials.

The above enabled us at short notice substantially to alphabetize the entire list of cards by sorter, at a mere fraction of the cost of hand alphabetizing.

6.4 One digit (Column 17) of sex and color, compounded thus:

Column Position	
1	male—white
2	male—colored
3	female—white
4	female—colored

6.5 Two digits (Columns 18-19) for month of birth.
6.6 Two digits (Columns 20-21) for day of birth.
6.7 Two digits (Columns 22-23) for year of birth.
6.8 One digit (Column 24) for the teacher's nativity.

Without appreciable extra cost in Hollerith card space each teacher of 46,000 teachers thus was uniquely coded. Upon repetition, this teacher's code number could be shortened appreciably and yet possess all the statistical properties of the present lengthy number.

7. The method of obtaining a distribution of the teacher's time allocated to teaching, supervision, administration and miscellaneous duties, in question 11, is worthy of notice.

The number of different kinds (school types) of *teaching* position of the teacher is punched into column 26 of the Hollerith card; and into column 27, the number of different kinds (school types) of supervisory position. The types a to i are given code numbers 1 to 9 and become the digits punched in columns 26 and 27 according to the "vote" recorded. In columns 28-43 of the Hollerith card will be punched the data of question 11 (type of school and per cent in each) insofar as the first two teaching and first two supervisory positions are concerned.

It will be noted that salary is punched in columns 58-61 of the card. By employing the principle of digiting it will be possible readily to estimate closely what proportion of Ohio's annual educational salary bill is allocated to teaching and to supervision in the nine different types of school (a to i) *without* the intermediate step of apportioning the salary of each teacher to the several kinds of school and to teaching as *versus* supervision. The question errs in assuming that all define teaching, supervision, administration and miscellaneous, in like manner. Note the use of explicit definitions—what to do if you teach only, or supervise only, or do not teach, or do not supervise; also the checking features—particularly printed "100" and use of single and double asterisks, and their corresponding footnotes. This is about as complicated a two-way table as one can hope to have teachers fill out successfully without personal, and verbal, guidance and supervision.

8. The Hollerith card provides for punching six teaching subjects taught by the teacher. These are precoded at question 13, thus saving an enormous coding bill. The same codes are employed for major and minor subjects of training (question 28) so that a two-way frequency table (contingency table) of Question 28 (X) against Question 13 (Y) will reveal at a glance all cases of misplacement of teachers—those trained for one subject but teaching another—for all these will be frequencies occurring in other than the diagonal row of the table.

9. Question 17, punched in columns 63-64, when taken in connection with Question 14, enables one to note the promotions, by $100 intervals, occurring since last year. In obtaining this by tabulation, one first orders the cards by the first two digits of present salary (minor control) (Columns 58-59 in tabulating) and then by last year's salary (Columns 63-64, major control in tabulating). The tabulating machine then records the number of all actually-occurring combinations of salaries thus:

Last year's (1929) salary in 100's (Major control)	This year's (1930) salary in 100's (Minor control)	No. of Persons	Major Total
28	32	3	
28	31	8	
28	30	130	
28	29	160	
28	28	250	
28	27	15*	
28	26	2*	568
27	31	5	
27	30	14	
27	29	162	
27	28	185	
27	27	242	
27	26	3*	611
26	32	1	
.	.	.	
.	.	.	
.	.	.	
.	.	.	
.	.	.	

The record shows three persons promoted from 2800-2899 salaries to 3200-3299 salaries, or a promotion of $400; eight with promotions of 28 to 31; and, later, 15 of demotions 28 to 27; 2 of demotions 28 to 26; and a total of 568 receivers, last year, of $2800-2899 salary.

The variety of insight into Ohio's teaching population rendered possible through the punched and verified Hollerith cards, can only be realized when it is remembered that at the rate of 24,000 cards per hour per trait,

* Starred frequencies connote demotions, or more probably salary cuts.

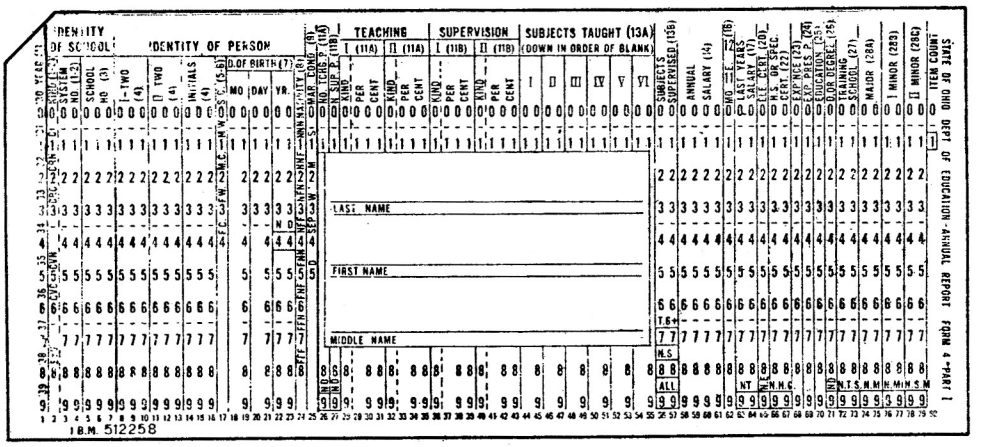

FIG. 148

the cards may be sorted in any way desired, e.g. to obtain the cards of the male-white teachers of Latin of five but less than ten years experience in their present school positions, who have college M. A. degrees or equivalent; and that thereupon from these specially selected cards two-way tables of every variable paired in turn with every other variable (several hundred possibilities) can be constructed at the rate of some 9,000 cards (tally marks) per hour on the tabulator.

To the extent that all the possible questions are asked of teachers, this one annual report renders ineffective any demand for special questionnaires to be addressed to the teachers. Within the limitations of the questionnaire, these are *the* facts about *the* teachers of Ohio as to sex, color, age, salary, promotions, training, subjects taught, effectiveness of use of special training, kinds of certificates,—or any possible simple or complicated combination of these.

By such means the executive head of a state school system may determine exactly the service, salaries, tenure, turnover, and adequacy of placement of the teaching force of a state and so be in a position to correct, by specific recommendations, the local deficiencies noted; and, by long-term instruction, propaganda, and legislation, the more generally distributed inefficiencies. Many teachers, for example, who majored in English in college are found to be teaching social science or mathematics, and *vice versa*. By such analyses the raw material of the colleges may be bettered, because the placement, training on the job, and happiness of the teachers of future college-going high-school pupils by such means will have been bettered.

This same principle of getting-all-the-facts is exemplified in our uniform college-entrance blank referred to above. In such a study one proceeds to determine all the desirable questions by a searching and thorough investigation; asks them uniformly of all the actual and potential applicants irrespective of college-going intention and irrespective of specific college choice; punches the results into Hollerith cards; analyzes the results; and comes finally, in all

probability, to a conclusion of a need for a startling change of policy. By such means the raw material of the colleges likewise will be bettered because those coming to college will be more capable, better fitted for college work, better motivated, surer of their occupational choices and colleges selected.

Finally the well-instructed, well-guided pupils come to college. Here, according to the prevailing philosophy of progressive education, the student's individuality counts. Accordingly we have projected an individual student perpetual personnel inventory Hollerith card to be punched up for every student-course-enrollment, some 50,000 each semester for a university of 10,000 students. In brief, this card will contain four classes of information:

1. *The raw materials* of educational production—the student's traits; his intelligence, transmuted high-school scholarship, scholastic tests, and aptitude measures, such as mechanical ability, social intelligence, socio-economic index, and high-school activities index or indices.
2. *The educational environment* provided for or chosen by the student—the course enrolled in, its credit, the rank, training and experience of the instructor (embodied in a meaningful instructor's code number*), the floor, room, building, hour of day, and other-to-be-discovered useful indices of the educational environment provided.
3. *The educational results*—a series of indices (not generally or only the present grades and marks) of the student's scholastic attainments in such sub-divided aspects of college success as thinking ability, technical vocabulary, information, ability to apply principles to concrete problems, and ability to infer social implications or consequences. Scholastic success is not unitary; and we shall need to construct such indices as the above if we are truly to represent the real success of the student, for, obviously, he may succeed in any one of these while utterly failing in another. "Success is a profile rather than a single index" say all progressive modern educators. Persistence data also will be an important part of this class of data.
4. *Educational individual costs* of the student's attendance upon the course. This will involve a one-step-further breakdown of the university costs, the allocation of costs to courses instead of to departments only as at present (see footnote, page 195). Then as a first approximation we may allocate to each student of a course 1/nth of the cost of the course; i.e. 1/40th of the cost of a course of 40 students; 1/16th of the cost of a course of 16 students.

From the resulting cards, once the system has been in effect for a few years, on short notice one will be able to extract almost any desired information about all or any part of the student body, typified by such questions as:

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* A thoroughly meaningful code number is a series of variables, each useful to an administrative officer to know for itself, yielding sufficiently differentiating numbers that all persons, for example, receiving such code numbers are differentiated from every other by the property of possessing a different or unique number. As an example, the meaningful code number 1096032714 might be interpreted as a "male" (1), who is 96 in intelligence (096), born on March (03) the 27th (27) of 1914 (14). There are in general two statistical requirements of the variables to be chosen: Low correlation—ideally zero—among the "traits" employed and a great many categories in each variable, e.g. 100 in intelligence and 12 months and 30 days or 360 days in the year. In the example cited, we are able to write the same code number in several less digits than have here been employed. For populations below a certain minimum in size—to be determined empirically and verified theoretically, no two persons are likely to get the same coded meaningful identification number.

How many students of each degree of intelligence remain to the end of the sophomore year?

What was the scholarship of those graduating in exactly four years time?

What is the validity of our intelligence tests in all the specific courses of the university?

How many and what students are retarded?

How many female students took Psychology 401 at 8 o'clock last year?

What was the extent of the utilization of each class-room at each hour of the day last year? The year before last? And the year before that?

What is the money cost of this (specified amount and kind) instruction?

What was the cost of reteaching failing students last year?

How many class-hours of instruction of students of "superior intelligence" did each instructor do last year? The previous year? And the year before that?

Which is cheaper, method A (environment A) or method B (environment B), with students of each of the several types (raw traits) in order to secure a particular educational result, e.g. thinking power?

A surprisingly small number of well-chosen items of statistical information regarding each course-enrollment will thus lead to a degree of potential control over the educational business now seldom visualized, not to mention hoped for as "an attainable good" procurable short of super-human effort. By such means university policies—like those of a certain few industral businesses—in time may come to be determined mainly by fact rather than by opinion and heated discussion.

Thus, in common with Buckingham,** we may assert that statistical thinking, about education, is a new and most powerful mode of thinking.

In connection with the above we mentioned transmuted marks. The problem here is that of rendering comparable the marks of college applicants from high schools widely scattered over the state. Many different marking systems are reported to exist; many more than are reported actually do exist. The

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* *The* cost of any individual's instruction, like that of any unit of production in a large factory, is an idealization only. Depending on the purpose at issue one may employ either a crude approximation or finer and finer indices as befits the need of the moment and the prospective needs of the future. The principle is that one should include in the cost of a course, and in the cost of an individual's course, whatever differential cost components will yield the most *educationally enlightening* cost figures.

On the one hand we might make the simple, but nevertheless very crude assumption—possibly accurate enough for many purposes, but certainly not for all—that every student-teaching-hour within a department, regardless of courses, costs the same, namely 1/nth of the cost of the department, where n is the total student-teaching-hours of the department. In a large university with more than three score departments, these costs will vary considerably, reflecting the general trend of instructional equipment and other costs which undoubtedly vary widely from department to department. A very simple use of the Hollerith multiplying punch, using a constant departmental multiplier of costs and the variable, student hours, as multiplicand would be ample to secure the student individual cost figure in this case.

At the other extreme we have a course-cost which reflects adequately the differential cost of each course as due to differential salary cost of instructor and assistants, differential equipment and supplies, and, differential course overhead as well as certain constant departmental overhead and university overhead charges. (Such subdivisions of costs, if plotted annually, are one of the most effective ways of locating cost "leaks.") These figures require, obviously, some thought and accounting research and labor in their construction.

It is primarily to this second type of individual cost figure that the thought of the text is directed. By the first index, every student hour of instruction in a department costs the same. By the second, intra-departmental courses open to seniors cost more than courses open to freshmen, since the personnel in general is paid more; the non-technical courses of a department cost more than the technical, since both more and more costly equipment in general is used; and the graduate work of a department costs more (per course or per student) than undergraduate, for both reasons. At the present moment we can do but little more than say that the problem needs to be studied thoroughly before adopting any method of individual student-course cost.

** Buckingham, B. R.—Thinking Statistically. Educational Research Bulletin, Vol. 6, March 30, 1927, pp. 142-143.

problem is further complicated by the fact that even if identical distributions of marks should be given in two schools the marks in general would not be comparable due to the fact that the intelligence distribution of any two in general is different, there being very wide extremes in average intelligence scores of graduating seniors within the boundaries of a state. Concretely, a mediocre mark in a school with a very high average of intelligence is "good" and a high mark in a school with a very low average of intelligence is "mediocre." As a first approximation, then, we may assume that "the average attainment of pupils of equal intellect (and the same school standing, viz., seniors) is equal in all schools," thus for the present ignoring the (probably small) "differences in efficiency of schools," This assumption enables us to devise equations by means of which a table of equivalences may readily be written for transmuting to a common standard the marks of any pupil of a given school.* One such table must be provided for the seniors of every high school, and the tables must be revised frequently. By such means we shall be able to salvage the predictive power of high school marks in the prognostication of college success and so add at little cost a powerful variable to our battery of guidance instruments. High school marks have character quality inherent in them if by such means we can draw it out.

The practical realization of this project involves the problem of quickly finding the regression equations involving some 50,000 high school seniors distributed among some 2,000 high schools. We have previously discovered by a correlational analysis that the first 3 or 3½ years of the high school record is practically as valuable for prognosticating college success as the entire four years record.** Accordingly, it will be possible to utilize the senior year of high school functionally speaking, more and more for guidance, remediation and specific occupational preparation of pupils; and, statistically, for preparation of a centrally compiled directory of all seniors together with all their pertinent traits, transmuted wherever necessary to a common basis.*** These could be mimeographed and distributed to all colleges of the state by, say, March 1, annually. Upon the problem of college selection, a concerted guidance-selection program then might be brought to bear.****

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* Toops, Herbert A.—The Transmutation of Marks. Ohio College Association Bulletin, No. 88, pp. 1093-2000.

** Hartson, L. D.—The Predictive Value of Three Years of High School Work. Ohio College Association Bulletin, No. 87, p. 1076.

*** All transmuting equations being of the type, $Y = A + BX$, where A and B are constants and X is, say, the averaged high school marks of an individual pupil, the constants A and B may be punched into a senior's card as a part of a thus meaningful code number of *the pupil's high school* in question while the X, the averaged mark over three or three and a half years of the given pupil in question is punched in later, perhaps, when it becomes available. The transmuted score, Y, may then be found† and be punched into the given pupil's card automatically by the Hollerith multiplying punch as $Y=1\times A+B\times X$, and may be checked readily for computation, for all the members of a high school, by the checking equation†† $\Sigma Y=AN+B\Sigma X$, where Σ means the added sum of all such scores (the tabulator-produced sums), and N is the number of high school pupils of the high school in question found by tabulating the item-count column of the card.

**** Toops, Herbert A.—Tests and Techniques in a State-Wide Minimal Guidance Program. 'Occupations, The Vocational Guidance Magazine, Vol. 12, No. 8, 1934, pp. 10-23.

See also, Toops, Herbert A.—The Possibility of General Selection. Proceedings of the Association of Ohio College Registrars and Examiners, 1933, 19 pp.

† See also Segel, David—The Automatic Prediction of Scholastic Success by Using the Multiple Regression Technique with Electrical Tabulating and Accounting Methods, Journal of Educational Psychology, Vol. 22, No. 2, Febr. 1931, pp. 139-144.

†† A checking equation is an equation which, if satisfied by the substitution of the obtained tabulated sums, gives indicative proof of the probable correctness of the computations.

With the 50,000 records resulting for a state, the reproduction of any selection made from such cards—for example, all the students emanating from a given high school, or all the students entering a given college, or all the students of better than 90-percentile intellects—can quickly be made if these cards have the name of each pupil punched into the card and if the alphabetical tabulator be employed for the listing of the cards.

The data resulting from all such scores and transmuted scores become, once the pupil has enrolled in college, the "raw traits" of the student's perpetual personnel inventory card above mentioned, the method of obtaining the transmuted scores of course being omitted from the latter as unessential to its purpose. Accordingly, it were well that the former card be so arranged that, if possible, the pertinent information desired may be copied from the former to the latter by the automatic duplicator.

The Hollerith individual record card will be indispensable in utilizing the vast stores of information about the pupils of a state which will accumulate annually if we are successful in inaugurating only a few of the proposals for a minimal state-wide guidance program, viz.:

1. Annual intelligence tests of every pupil throughout his high school career.
2. A uniform college entrance blank, filled out annually by all high school seniors.
3. A uniform high school cumulative record system.

Such a program in the secondary schools must be paralleled by a comparable personnel, guidance and curricular-revision program in the colleges if the full benefits of the proposal are to be realized.* This program is not being lost sight of in Ohio as the 93 Ohio College Association Bulletins will attest. Some of the key problems noted here, are:

1. The translation of the student's traits into such terms that the individual faculty member can understand and act upon them; and the supplying of each faculty member with such an abstracted record of each of his students. "Prevention is better than cure" is good personnel philosophy.

   It is possible so to punch up a student's record that the tabulator will reproduce a profile of the student's traits.

2. A means of improving the selection of new recruits to the college teaching profession.**

   By correlational analysis, involving, as a first step, finding all the intercorrelations of fourteen traits, it has become possible to inaugurate a policy of selecting departmental personnel by a method which is abbreviated over the highly statistical one presented in the reference of the footnote. It was

* Toops, Herbert A.—The Possibility of General Selection. Proceedings of the Association of Ohio College Registrars and Examiners, 1933, 19 pp.

** Toops, Herbert A.—Selection of Graduate Assistants. The Personnel Journal, Vol. 6, No. 6, April 1928, pp. 457-472.

found that the traits of greatest importance for psychological selection and departmental placement are research ability, scholarship in psychology, and specialized abilities (calculating machine operation, mimeographing, photography, slide rule, etc.) in decreasing order of importance. Accordingly, the number of applications being some eight or ten times the number of possible appointments, as is generally true nowadays, it is possible first to scrutinize all credentials carefully with respect to these three traits and so exclude an appreciable number of the least promising applicants, leaving a somewhat smaller number to be carefully scored on all fourteen traits; and yet not fall into the pitfalls of the successive hurdles method of selection.*

3. A faculty record card, and an annual personal and progress report of each faculty member which shall be a searching self-inventory for augmenting and keeping up to date the above record.

Regression equation analysis of such data has recently been shown by Ward** to be a useful means of detecting those faculty members most worthy of promotion, independent of departmental recommendations, so that a policy of professional growth may be encouraged and promoted by the university administration.

In all these the availability and usefulness of the data will be enhanced greatly by being punched into Hollerith cards. The essential requirements are (1) quick sorting for any traits or *patterns* of traits desired; (2) listing of entire cards simultaneously, or of any desired part thereof, while changing the printing order of the traits according to requirements; (3) tabulation of the traits; (4) multiplication of the scores in traits by pairs and the cumulation of the sums produced. Most of the necessary statistical techniques have now been worked out and shortly will be published.***

For the research problems of the various departments of a university, the Hollerith machines are admirably adapted. Often-used theoretical equations, for example, frequently may be reduced to tables which may be constructed automatically on the tabulator; and once a larger capacity tabulator becomes available such operations will be much facilitated.**** It is obvious that almost any of the simpler scientific equations of use in mental measurement would generally be more useful if reduced to tables. With this time-saving equipment one can collect data on sufficient cases to insure the validity and reliability of empirical formulae and for these formulae tables likewise may be constructed "automatically" by the machines. For the greatest value in this connection, the tabulator will need to be equipped so as "to retain an impression of

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* Toops, Herbert A.—Sifting Civil Service Applicants by the Successive Hurdles Method. The Personnel Journal, Vol. 11, No. 4, December 1932, pp. 216-219.

** Ward, Jesse L.—The Development of Faculty Personnel Accounting Forms for an Institution of Higher Learning, Ann Arbor, Michigan, Edwards Brothers, 1934, 141 pp.

*** Toops, Herbert A.—Questionnaires, Standard Codes and Hollerith Machines. Chapters 10 and 11.

**** Edgerton, Harold A.—A Table for Finding Point-Hour-Ratios and Standard Scholarship Rates. Ohio College Association Bulletin No. 43, pp. 353-359+21 pp. of tables.

a card" and "to repeat it any number of times as addend," comparable to the function of the "lockdown" key of the adding machine.

In our more theoretical researches, for example, we have recently discovered a means of coding *alternative* answer patterns to objective test questions by a self-coding procedure. Questions 36 and 37 of the Further Educational Intentions blank (q.v.)—now compound-coded for punching in four categories (no-no=1; no-yes=2; yes-no=3; yes-yes=4) in column 55 of the Hollerith card—will serve for illustration. The possible answer alternatives may be pre-coded with addends thus:—

Q. 36. If an average four-year university course costs $2500, is your family *financially able* to bear the cost of such a course for you? (Note: This is about $625 per year for *each* of four successive years.) [1] No [2] Yes

Q. 37. If an average four-year university course costs $2500, is your family *willing* to bear the entire cost of such a course for you? [3] No [6] Yes

If the addends printed in front of each answer alternative be added for the pattern of answers elected by the examinee, the resultant summated code number yields a *unique* pattern of answer-codes, showing uniquely all possible patterns of answers *including omissions,* as shown by the following table:

DECODING TABLE

Code No.	*Answer Pattern*
1	"No" to Q. 36; omit answer to Q. 37
2	"Yes" to Q. 36; omit answer to Q. 37
3	Omit answer to Q. 36; "No" to Q. 37
4	"No" to Q. 36; "No" to Q. 37
5	"Yes" to Q. 36; "No" to Q. 37
6	Omit answer to Q. 36; "Yes" to Q. 37
7	"No" to Q. 36; "Yes" to Q. 37
8	"Yes" to Q. 36; "Yes" to Q. 37

These—only one choice or no choice (an omission) per row—are exactly the requirements for the objective multiple-choice questions which now are so widely used in tests and examinations. An inspection of the following sample test will show that every allowable pattern of test response is provided for:—

Four-choice tests

The longest river of the U. S. is the

1 Columbia 2 Potomac 3 Mississippi 4 Rio Grande

The color of lemons is

5 purple 10 yellow 15 green 20 violet

Who was president of the U. S. in 1863?

25 Jackson 50 Tyler 75 Harrison 100 Lincoln

From the above it will be seen that:

(1) the addends of the first row are 1, 2, 3, 4.....N; where N is the number of answer alternatives common to all the questions;
(2) The first addend of each row thereafter is found by adding the first and last addends of the previous row; thus in the four-choice tests 5 is the sum of 1 and 4; 25 is the sum of 5 and 20.
(3) The second, third and fourth, etc., addends of any row are, respectively, 2, 3, 4, etc., times the initial addend of the row in question.

It is clear that this coding system *may* be of much value in differential psychology since it enables us to code and handle with greatest ease individual *patterns of response.*

The greatest fault with the system is that the addends soon become large, as may be noted from the example above, or as may be inferred from the formula for an addend*:—

$$A=n\ (N+1)^{m-1}$$

where A is the addend sought for an alternative which is the nth position of the mth row, or question, of a table of answer alternatives where each question has N alternatives.

Suppose for example we wish to verify the correctness of the code addend written before "Lincoln" in the above example. Now "Lincoln" is the 4th alternative (n=4) of a 4-choice (N=4) set of alternatives, and occurs in the third question (m=3).
Accordingly,

$$\text{Lincoln}=4(4+1)^{3-1}=4\times5^2=100;$$

which proves the correctness of the entry in question.

The number of code-numbers possible also soon grows quite large:—

$$S=(N+1)^m-1$$

where S is the maximal code number which must be provided for on a Hollerith card if we would provide for punching-up all possible patterns of response.

In the above example, (m=3—question; N=4-choices)

$$S=(4+1)^3-1=5^3-1=124;$$

which, it will be seen agrees with the code number of a pattern of response: "Rio Grande, violet and Lincoln"—the maximally coded alternative of each row of which the addends are summated to yield the maximal code number.

Accordingly, then, for three 4-choice questions one must provide on a Hollerith card for 124 code numbers if all possible patterns are to be punched.

Obviously, answer keys to tests may be similarly coded, by simply underscoring throughout on such a blank the correct answers to the several questions and then adding the corresponding addends. In an emergency this would be a quick way to transmit an answer key, by telegraph for example, and at all times a scientific way readily to refer to such a key. (See footnote,* p. 201.)

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* This, and the following formula are given here merely to emphasize once more the possibilities of control of Hollerith operations when we have a mathematical formula for every code employed.

One possible application of this coding scheme to another purpose is in representing test profiles. Suppose a person's standing be represented by three degrees only plus one additional category:—"high" (in the top third), "average" (in the middle third) and "low" (in the bottom third) and "ability absent" (or "not measured"). Suppose further that those research workers who are working with aptitudes and "mental factors" should find that the important ramifications of human ability could be measured and encompassed by reporting an individual's status on, say, only six such unique tests. In this event, the above coding scheme might be applied to the individual profiles; unique traits replacing questions and being m=6 in number; three degrees in each trait (N=3) replacing the four alternatives to each question of the above example; and, n becoming the individual's status (ordinarily called X) in each trait, either 1, 2, or 3 depending as the individual is in the bottom, middle or upper third, respectively of each measured unique trait in question.

Solution of the above formula shows (when N=3); (m=6) that there would be only 4096 different patterns of humans (both measured and partly unmeasured; a number which is both far less than the "infinite variety of human nature" posited by the average layman, and well within the possibilities of empirical investigation by mass survey methods since in the above there are only 3^6=729 basically different *measured* patterns of human ability. If these patterns were all equally frequent**, then in a state high school population of 300,000 we should find some 400 of each pattern. By follow-ups conducted on the same scale, we should soon learn, for example, "what patterns, if any, are most essential for success in which occupations". Such hypotheses at present obviously are only speculations at best, but nevertheless are necessary ones if human mensuration ever is to take its proper place in the scientific sun in accord with the dictum that "The proper study of man is man."

It remains to be seen whether we can work out a coding system which will need to make no provision for unmeasured or omitted data for each question or trait at issue. Because of the smaller requirements as to size, both of individual and of summated addends, this code would be far more useful in the above problem of unique ability profiles than is the one presented which, however, is ideal for the general case of multiple-choice test responses with omissions allowed.

If *all answers of a row* are possible, we obtain a still larger code in which the addends are made up of the successive powers of 2 as in the following

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* If the number of questions be kept to a minimum as where rigorous item selection is employed, clearly it may be possible to devise a machine for determining the code number of the pattern of response *accurately* and automatically—as is necessary if the plan ever is to become practical—and then the code number of the students' answer pattern being available, by looking in a book one may find opposite the code number several entries or normated entries such as: (1) The individual's score on the test (since for a given code number of answer key (X), a given pattern of test response (Y) has only one possible number of correct answers); (2) his probable college scholarship; (3) his probable length of college persistence, in semesters; (4) his chances of attaining Phi Beta Kappa;—or, in general, any estimate of his future behavior which is expressed solely as a function of his total number of correct responses on this particular test as scored by this particular scoring key (it being assumed, of course, that the several correct answers are simply added to obtain the student's score.)

** Unique traits—such as the six posited—are uncorrelated, making this assumption of equal frequency in a *random* sampling of the population a very plausible one.

example—which is rather highly artificial in the interests of brevity and clearness of presentation:—

Q. 27. Underscore the states in which you have *lived*: 1 Ohio 2 Indiana X Neither Ohio nor Indiana

Q. 28. Underscore the states in which you have *voted for president*: 4 Ohio 8 Indiana Y Neither Ohio nor Indiana

Here, clearly, one may properly underscore none, any one, any two, any three or all four of the *numbered* alternatives, the code number for which last-named pattern of response is "15".

This geometrical coding system* is very useful, also, for precoding multiple reasons, multiple opinions, and the like, where the several reasons are given in a list so coded, and where any one or more up to and inclusive of all the alternatives are electable by the examinee, for example:

Check "X" any and all reasons which were factors in causing you to move to Columbus:—

1 ☐ Cheaper rent
2 ☐ Lower taxes
4 ☐ A wider variety of industries
8 ☐ Higher wages
16 ☐ A promise of steady employment
0 ☐ None of the above

Like the former this is a unique code—i.e., all patterns have a code number, and all numbers have one and only one pattern corresponding.

The above are given to show that Hollerith equipment for the first time makes possible an empirical attack on rather important theoretical questions which can be answered only by theorizing followed by extensive empirical attack for verification. If the equipment plays a stellar role in theoretical research, it plays an even more important part in the routine researches of a college faculty.

Hollerith equipment has been used in our office for constructing division tables; point-hour-ratio tables; for scoring multiple-answer tests, revealing either the right or wrong responses as desired;** for determining the winners of state-wide pupil cattle-judging contests;*** for affixing norms to test results; for determining the significance, other things being equal, of qualitative information; for determining the "factors" inherent in test data and scholastic marks; for analyzing physical education records and the student personnel records accumulated by the registrar; for determining those students, seeking

* See also Dunn, Halbert L.—Application of New Geometric Code to Multiple Punching in Mechanical Tabulation. Journal Am. Stat. Assc., Vol. XXVII, Sept. 1932, pp. 279-286.

** Toops, Herbert A.—The Use of the Hollerith Punch Machine in Scoring and Analyzing Tests of the Multiple Choice Form. Ohio College Association Bulletin No. 67, pp. 752-757.

*** Jackson, Lyman—Report of the Proceedings used in the Tenth Annual Vocational Agriculture Judging Contests, Ohio State University. 1931, 16 pp. (unpublished report).

work, who have the best pattern of skills for the work of a proposed employer; to determine the most important characteristics of a progressive county and so to list the "black spots" of the state;* to determine a minimal salary formula for the teachers of the state in state-aid territory; for determining the best tests to be combined for the construction of intelligence tests and aptitude tests; for determining the minimal number and the identity of the traits to be collected for each student so that a meaningful code number constructed therefrom not only will have a high probability of uniquely establishing his identity for all time among tens of thousands of students but also at the same time will provide data about the student useful to those initiated into the interpretation of the code number;** for researches in Agricultural Economics, e.g. the economics of milk production; for researches in the Bureau of Business Research, e.g. the economics of chain store selling; for researches of the Bureau of Educational Research, e.g. the number-concepts of pre-school children; for researches of the Department of School Administration, e.g. the operation of the compulsory attendance law among continuation school pupils; for researches of the State Department of Education, e.g. item analysis of the responses of pupils on the state-wide scholarship tests and the state-wide teacher survey above mentioned; and a varied list of researches of individual professors and graduate students who flocked to the machines once their availability became known and a few researches had been carried successfully to completion.

It is the belief of the writer that any college which purports to do research cannot afford to do without Hollerith equipment. Any large university cannot afford not to have a least two sets of equipment, one for the use of the administrative offices and one for the research uses of the faculty and students. In the latter case, it is most necessary, in the writer's opinion, that an adequate questionnaire and research advisory service be available; that the operator be more than usually intelligent, adaptable, and amenable to the acquisition of new methods, and be totally free of the "I can't" complex; but even more important, that the equipment be under the supervision of a technically competent research worker; and last but not least important, that there be no financial strings on the use of the equipment by faculty members.*** Research productivity is its own justification and its own reward. The right arm and brain of any research man can be multiplied by at least ten by the judicious use of Hollerith equipment. Our estimate is that the effectiveness of most psychological testing and personnel research can be multiplied by about fifteen by this means.

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* Hall, C. W.—The Collection and Evaluation of Socio-Economic Indices in Relation to Educational Variables. Unpublished Ph. D. Dissertation, O.S.U. Library, 1931, 262 pp.

** Royer, Elmer B.—A Unique Code Number. Unpublished O.S.U. Thesis, Library, Ohio State University, 1931, 35 pp.

*** Universities, colleges, municipalities, governments—the so-called "non-productive" employers generally have a most curious short-sighted personnel philosophy in this respect, it would seem to the writer. They hire—i.e. rent—a most expensive executive, research worker, or investigator. They then fail to supply him adequately with the dictating machines, calculating machines, typing assistance and the like necessary to get the value or return out of their already heavy investment. An expensive high-power gun without cartridges is of no use to a lion hunter. A high-power brain, without tools is almost equally useless to one of the non-productive institutions named: and moreover becomes a lifetime liability which does not decrease the institution's outlay at the age of retirement.

When one examines the literature in the field of the writer's interests one finds that probably two-thirds or more of the researches reported were based on too few cases to justify the conclusions made.* Furthermore, few of the studies were adequately controlled; and all too few are ever repeated. To find intercorrelations of the men, and also of the women, and of both combined, for example, by hand work is seldom done; but with the assistance of the tabulating machines, the cards of the men may be sorted while the cards of the women are being tabulated and *vice-versa,* so that the operation of finding both sets is little, if any, more laborious, so far as the machine work involved is concerned, than to do the one alone. Then by simple addition of corresponding quantities the results for both sexes combined readily are found. As many as four or five sets of data—repetitions or successive samplings of an experiment, for example—may be thus managed without confusion by two operators, one for operating the sorter and one the tabulator. Thus we may secure an empirical check on the reliability of our samplings independent of the (oftentimes dubious) assumptions of our probable error formulae.

In the future it is the writer's belief that we shall see much more attention devoted to the study of the influence of sub-groups of people, which combine to make large groups, in their effects upon the phenomenon at issue, say scholarship. By employing enormous populations and punched cards, one can sort out and so obtain sizable populations for different traits and control them very precisely through the major, minor and other control boards and then list the resulting selections with the appropriate tabulations on the printed record. Thus in time will be secured a precision and a dependability of research in the social sciences second only to those now conducted by the physical scientists.

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* In support of this contention see also Dunn, Halbert L.—Application of Statistical Methods in Physiology. Physiological Reviews, Vol. IX, No. 2, April, 1929, pp. 275-398.

PART V

Applications in Psychology and Educational Research

CHAPTER II

Analysis of College Test Results

By
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DURING recent years it has become increasingly apparent to thoughtful educators that school children and college students alike need constructive long-term guidance quite as much as they need teaching; indeed, a considerable proportion of the maladjustments and pupil failures in our schools and colleges have been attributed, with considerable justice, to the preoccupation of teachers with the curriculum and to their neglect of the individual needs of their pupils. Many progressive teachers have come to realize that the curriculum is not an end in itself, but merely an instrumentality whose only justification is its contribution to the better citizenship of the rising generation. Formerly children were "flunked" if they "failed" any part of the curriculum, and were often "flunked" entirely *out* of the school or college if they "failed" more than a certain fraction of the prescribed curriculum; but now there is a strong tendency developing on the part of many teachers to discard the part or parts of the curriculum that are failed rather than to discard the pupil or pupils that failed such part or parts of the curriculum. To "fail" pupils on the scale on which they have been "failed" in the past is now recognized as an evasion of school duty in precisely those individual cases in which the school's opportunity for service was greatest and most crucial for the welfare of both the individual and society.

The welfare of the individual in society is now definitely recognized as paramount to the integrity of the curriculum, and in consequence most enlightened teachers recognize the function of guidance of individuals as a professional duty which is prerequisite to an economical and constructive fulfillment of their teaching duties.

Effective guidance depends on learning the abilities, achievements, and interests of individuals, just as good medical practice depends on careful diagnosis of the ailments and needs of patients. School children are as complex educationally as they are medically; and educational diagnosis, like medical diagnosis, depends upon information of many types from a great number of sources. One of the most fruitful of these sources has been found to be objective tests of aptitudes and achievements which yield comparable measures. The interpretation and use of such test results for the diagnosis, guidance,

and remedial treatment of individual pupils has been found to be most fruitful and economical when the tests are given coöperatively by many schools, as in city-wide, state-wide, or nation-wide testing programs. But the advantages of large-scale programs cannot be effectively realized unless the results from all cooperating schools can be expeditiously, accurately, and economically collated. This condition for the effective use of test data has been met by the Hollerith tabulating machines, as, for example, in the case of the Iowa Every-Pupil Testing Programs, mentioned elsewhere in this volume, and in the case of the nation-wide college testing programs of the Committee on Educational Testing of the American Council on Education, of which the 1933 program is the subject of this chapter.

In May, 1933, more than 150 colleges in 40 states gave one or more of a dozen tests to over 10,000 sophomores, and to many additional pupils in the freshman, junior, and senior college classes. These tests included the following: English (Spelling, Usage, Vocabulary) 255 items, 95 minutes; Literary Acquaintance, 200 items, 45 minutes; General Culture (history, economics, government, sociology, psychology, foreign literature, fine arts), 803 items, 180 minutes; General Science, 270 items, 60 minutes; General Mathematics, 166 items, 120 minutes; French, German, Spanish or Latin, 280 items, 90 minutes each. The colleges used these tests in a great variety of combinations, for exceedingly variable selections of students from the various classes and thus presented quite a complex collating problem that would have been prohibitive in time and cost without the aid of Hollerith equipment. A few of the more general statistical treatments of the vast body of data will be described briefly in this paper.

Data Sheet

Most of the tests were scored at the colleges where they were given, and all test results were reported on the Report Sheet form reproduced herewith. (Fig. 149.) The first five lines on the sample sheet are filled in from a *bona fide*

Report Sheet (to be sent to Cooperative Test Service, 500 West 116th St., New York City, before May 10, 1933)

Name of Institution Collegiate College (23) Address New York, New York Division or college tested Liberal Arts (1)

Of which class are the following students members? (circle one) F. So. Jr. Sr.

Column numbers		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Names in alphabetical order, last name first	Do not write in these spaces	Sex	Age at last birthday	Degree sought	Prof. goal	Hist. and S.S.	For. Lit.	Fine Arts	Total Gen. Cult.	Eng. Usage	Spell.	Voc.	Total Eng.	Lit Acq.	Gcult. + Eng. + Lit Acq.	Gen. Sci.	Gen. Math	Foreign Language Yrs. H.S. or Lat.	Foreign Language Yrs. Col. Cr.	Score	Av. Col. Gr.
Smith, Helen	0 0 1	F	20	2	2	64	59	47	170	84	33	60	177	64	411	37	25	G	2	32	4
Row, Richard	0 0 2	M	19	2	1	121	82	90	293	56	53	79	188	72	553	85	47	F	3.5	152	7
White, John	0 0 3	M	18	3	3	58	23	10	91	48	19	31	98	25	214	77	105	L	3	195	5
Williams, Mary	0 0 4	F	21	5	5	109	97	99	305	77	54	79	210	55	570	62	69	S	2	120	6
Winters, Jane	0 0 5	F	19	2	5	100	100	99	299	87	50	85	222	96	617	82	42	F	1	79	6
Punched Card Columns	6 7 8 9		10-11	12-13	14-15	16-17	18-19	20-21	22-23-24	25-26-27	28-29-30	31-32	33-34-35	36-37-38	39-40	41-42-43-44	45-46-47	48-49-50	51	52-53	54-55-56	57
							Columns 58					59		60	61	62	63				64

FIG. 149

college Report Sheet. The numbers in the seventh line show the card-column numbers in which the scores or code numbers in each column of the Report Sheet were punched. For convenience of securing card counts in cases where some students in a college failed to take one or more of the tests, a "1" was punched in the card columns indicated in line 8 if the test or group of tests was taken, and a "0" was punched if the test or group of tests was not taken. College numbers were assigned to the colleges in the order in which the reports were received, and serial numbers were assigned to the individual pupils in the same order. The data on college grades and chronological age were obtained from the participating colleges in accordance with the following directions:

"It is requested that age at last birthday and average college grade be indicated for each student who takes one or more of the tests. In reporting the average grade the code given below should be used. This code is necessary because different institutions use different symbols for grades, some using letter grades, A-B-C-D-F or E-G-F-P, etc., and some using percentages. In order to maintain comparability as far as possible between the grades for different institutions it is requested that you transmute whatever system of grades you use into marks of Excellent, Good, Fair, Poor, and Probation. In some institutions only students who receive 95 or above may be considered excellent. In other institutions a student receiving an average of 85 may be considered excellent. The intermediate points in the code, namely, 2, 4, 6, and 8, are provided in order to permit adjustments in cases in which there is some doubt regarding the group in which the student's average places him.

9 Excellent
8
7 Good
6
5 Fair
4
3 Poor
2
1 Probational or Failing"

The code numbers for sex (Column 1) and foreign language (Column 17) were as follows:

1 Male	1 French
2 Female	2 German
	3 Latin
	4 Spanish

National Sophomore Percentile Tables

The first and most widely desired table was the table of national sophomore percentile scales. This table, a part of which is reproduced here for illustrative purposes, (Fig. 150) enabled each college to determine the national standing of each student who took one or more of the tests. The whole table in-

	Hist. & S. S.	For. Lit.	Fine Arts	Total Gen. Cult.	English Usage	Spell.	Vocab.	Total English	
No. of Colleges	124	124	124	124	132	132	132	132	
No. of Cases	8,996	8,996	8,996	8,996	10,161	10,161	10,161	10,161	
Mean	84	45	34	163	63	32	50	145	
Sigma	36.2	27.8	24.4	77.7	17.7	13.4	18.2	42.8	
Percentiles									%iles
100	220	215	210	610	115	56	95	250	100
99	177	133	111	386	96	54	87	228	99
98	164	119	99	355	94	53	84	221	98
97	157	111	91	336	92	53	82	217	97
96	153	104	85	320	90	52	81	214	96
95	148	99	80	308	89	51	79	211	95
94	145	95	77	299	88	51	78	208	94
93	142	91	74	289	87	50	77	206	93
92	139	88	71	282	87	50	76	204	92
91	136	85	68	274	86	50	75	202	91
90	134	82	66	267	85	49	74	200	90
88	129	78	63	256	84	48	73	197	88
86	125	74	59	246	82	48	72	193	86
84	121	71	57	238	81	47	70	190	84
82	118	68	54	230	80	46	69	187	82
80	115	65	52	223	79	45	68	184	80
75	108	59	47	208	76	44	64	178	75
70	102	54	42	195	73	42	61	171	70
65	96	50	39	183	71	40	58	165	65
60	91	46	35	172	69	38	56	159	60
55	86	43	32	161	66	36	53	153	55
50	81	40	29	151	64	34	50	147	50
45	76	37	26	142	62	31	48	141	45
40	72	34	24	133	59	29	45	135	40
35	67	31	21	124	56	27	42	129	35
30	62	28	18	115	54	24	39	122	30
25	57	25	16	105	51	22	36	115	25
20	52	22	13	96	47	19	33	107	20
18	50	21	12	92	46	18	32	104	18
16	47	19	11	88	44	17	31	100	16
14	45	18	10	83	42	16	29	96	14
12	42	16	9	78	40	15	28	92	12
10	39	15	7	73	38	13	26	87	10
9	37	14	7	71	37	12	25	83	9
8	35	13	6	68	36	12	24	80	8
7	33	12	5	64	34	11	23	77	7
6	32	11	4	61	33	10	21	74	6
5	30	10	4	57	31	9	20	71	5
4	27	9	3	53	29	8	19	67	4
3	24	7	2	48	26	6	17	62	3
2	20	5	1	42	23	5	15	55	2
1	14	3	0	32	19	2	11	44	1

National percentile scales for the tests given in May, 1933, to college sophomores. The scales are based upon returns from all sophomores tested, regardless of curricular division or type of institution, for whom reports were received up to June 10, 1933. These tables show true percentiles, calculated from the distributions of scores.

Each score in each column shows the upper score limit of the percentile indicated at the extreme left and right of the line. For example, the bottom entry in the History and Social Studies column shows that all scores of 14 or below have a percentile of 1; all scores from 15 to 20, inclusive, have a percentile value of 2; and all scores above 177 have a percentile value of 100. Scores of 82 to 86 have percentile values of 51 to 55, and scores from 77 to 81 have percentile values from 46 to 50. Many colleges used variant combinations of tests, hence the numbers of cases and of colleges vary from column to column. The mean and sigma of the scores and the number of colleges involved in each column are shown at the top of each column.

FIG. 150

cluded 27 columns, one for each of twenty-seven tests or test-parts given to sophomores. The percentile scores in each column in the table were calculated from the results of one run of the punched cards through a standard 80-column printing tabulator, wired for minor control on the columns in which the scores for a given test were punched. The score intervals were printed from the first counter, the card count or frequency distribution from the second, the total number of cases from the third, and the sum of all the scores from the fourth counter. The average or mean score was the quotient of this score-sum divided by the total card count, and the sigma was calculated by hand from the frequency distribution.

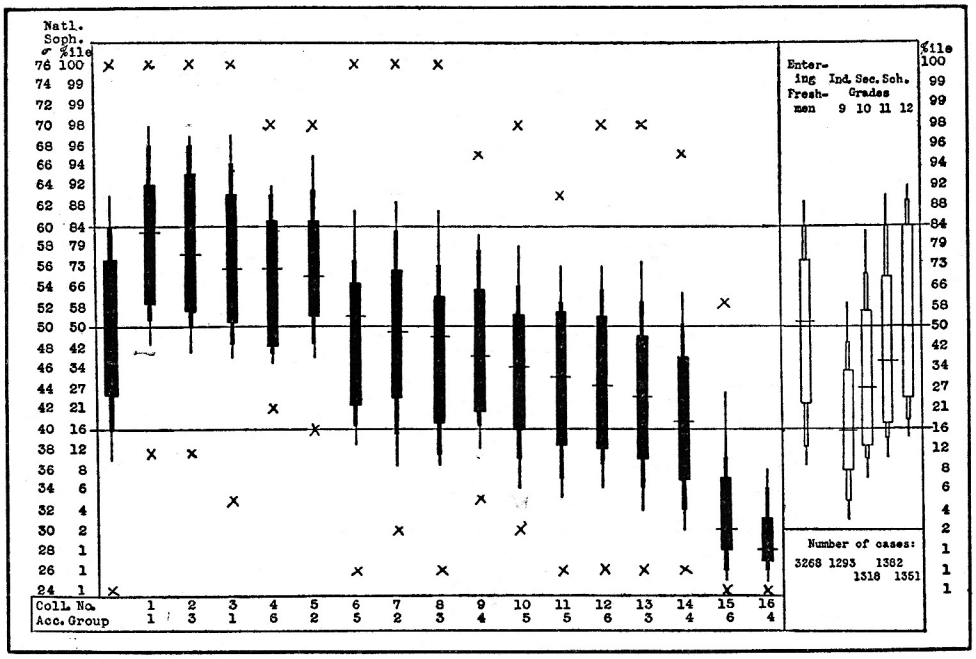
Variability of Achievement in Colleges

One of the most interesting of the many types of comparisons facilitated by the punched card analysis of the college test data is illustrated by Fig. 151, which is reproduced here, with accompanying discussion, from the *Educational Record* for October, 1933.

The sixteen colleges included in Fig. 151 were chosen to represent the whole range of medians from highest to lowest, and all types of institutions that gave the tests to sophomores and that reported results in time for inclusion in the report. The sixteen institutions include universities, four-year colleges, junior colleges, and teachers' colleges in more than a dozen states, and represent various types and conditions of accreditation and non-accreditation.

Fig. 151 shows two types of variability; the first is the variability of median scores of different colleges, and the second is the more significant variability of scores of students in individual colleges. While both types of variability indicate the great need for more adequate educational guidance of students, both before and after reaching colleges, the second type more particularly defines the immediate opportunity of the colleges to serve those young people who have already been admitted to college, and also, in cooperation with the secondary schools, to serve similar groups of young people who are planning, often unwisely, to come to college. The differences among the colleges whose sophomores participated in this program, as indicated by the differences displayed on this chart, are very large indeed.

The chart is particularly interesting because of the availability of comparable English test data on entering college freshmen and on independent secondary school pupils, represented by the five bars at the extreme right of the chart. The median score of 3,268 college entrants in 10 colleges in September, 1932, is slightly above, and the median of 1,351 twelfth grade pupils in independent secondary schools is just equal to, the national sophomore median. The sophomore medians on the English test are below the median of the ninth grade in five colleges and below the median of the tenth grade in twelve of the 130-odd participating colleges. One of these twelve colleges is fully accredited by a regional association. In one of these dozen colleges, about 95 per cent of the sophomores, and in another about 85 per cent of the sophomores, are below the ninth grade median. In the college which secured the highest median score in the English test, about 15 per cent of the sophomores are



Variability of achievement as measured by the total English test. The middle horizontal line shows the national median, and the other two are at the 16th and 84th percentiles of the national sophomore distribution. The first vertical bar represents the national group of sophomores from all colleges that took this test, and each of the other bars represents an individual college. The wide portion of each bar represents the range of scores of the middle half of the sophomores in each college. The narrow parts extend to the 16th and 84th percentiles in each college. The lines at the ends extend down to the 10th percentile and up to the 90th percentile. The crosses below the bars represent the lowest scores and those above represent the highest scores in the several colleges. The short cross line at the middle of each bar represents the median score of the college.

While this chart is based entirely on percentiles, the scale has been altered to correspond roughly to a sigma scale, so that vertical distances are approximately comparable. The sigma scale is derived from the percentile scale.

The sixteen colleges included here are chosen to represent the entire group of colleges that gave the tests to sophomores. All types of institutions are represented.

The five open bars at the right represent the distributions of scores on comparable Cooperative English tests (Series 1, 1932, and Series 2, 1933) of 3,268 freshmen entering 10 colleges in September, 1932, and of 5,344 pupils in independent secondary schools who took the tests near the end of the ninth, tenth, eleventh, and twelfth grades in April, 1933.

FIG. 151

below the twelfth grade median; and in another college, which is fully accredited by the A.A.U., more than half of the sophomores are below the twelfth grade median. On the other hand, the fourth highest college on the chart is not on any accredited list available at this writing.

Variability Within Colleges

While the differences between colleges are highly significant, the variability within colleges displayed in Fig. 151 is of even more profound importance for the philosophy and administration of American education. The spread of scores within a single college, from far below the ninth grade median of in-

dependent secondary schools to far above the national sophomore median, is of basic significance. If these indications are no more than approximately correct, the great need suggested is not so much a more ardent concern over the rectification of institutional standards as a humane ardor for finding and serving constructively the needs of individuals in the heterogeneous and largely overlapping masses that are now and will probably inevitably continue to populate both secondary schools and colleges. It is obvious that, with such student bodies as here indicated, mass standards and "average performance," even when relatively high, are not only irrelevant but ironical. It seems equally obvious that no simple and easy changes can be remotely adequate for making the readjustment demanded by the heterogeneity here exposed. Nothing short of a definite abandonment and repudiation of blanket prescriptions and unmitigated mass methods, and a genuine and whole-hearted acceptance of the fact of individual differences and their increasingly obvious administrative and guidance implications, would seem to be a sufficient reason for hopefulness in regard to this crucial social problem. The differences found here among colleges, and the variabilities within colleges, are almost certainly due, partly if not wholly, to differences in original ability which probably can not be equalized by any teaching methods now known. The indications of Fig. 151 are parallelled and confirmed by equal or greater differences in the achievements of college sophomores as measured by each of the other tests used in this program.

Distributions of College Averages

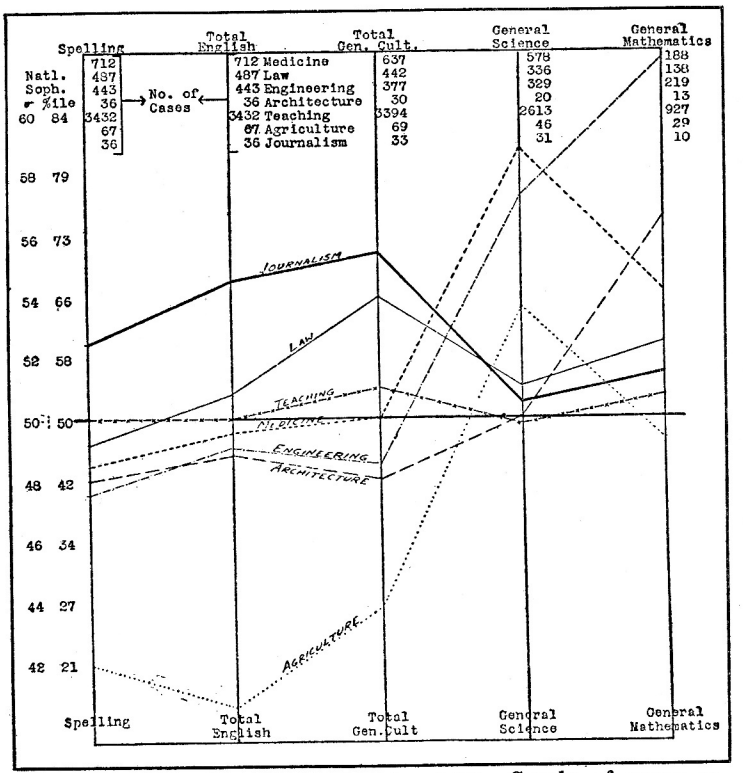
The average of each college on each test was expeditiously and economically calculated, once the data were punched on the Hollerith cards. For this purpose the tabulator was wired for minor control on the column for college identification number, which was printed from the first counter. The card-count was accumulated in and printed from the second counter. In counters 3, 4, and 5 the sums of the scores on three or more of the tests were accumulated simultaneously at one run of the cards, by splitting the counters whenever the test scores were numerically small, and the resulting sum would not exceed 9999. When all the sums were secured, each was divided by the corresponding card count, and the resulting averages were distributed as in Fig. 152.

This table confirms for all variables the indications of Fig. 151 that colleges differ widely with respect to achievement of the types measured by the tests. On some of the tests, several colleges secure mean scores which are at or above the 84th percentile, while equal numbers of colleges secure mean scores at or below the 16th percentile. This means that in some colleges roughly half of the sophomores are in the highest 16 per cent of the national sophomore group, and in other colleges roughly half of the sophomores are in the lowest 16 per cent of the national group. The importance of such differences, for admissions officers who are considering applications for advanced standing, and for those who are engaged in constructive educational guidance, can hardly be overestimated. These data emphasize the need for supplementing present appraising devices with instruments which yield more objective and more comparable measures.

Natl. Soph. %iles	Age	Hist. & S. S.	For. Lit.	Fine Arts	Total Gen. Cult.	Eng. Usage	Spell.	Voc.	Total Eng.	Lit. Acq.	Comb. Score	Gen. Sci.	Gen. Math.	Coll. Grade	Natl. Soph. %iles
98–100													1		98–100
96– 97						1							1		96– 97
94– 95				2					1				1		94– 95
92– 93												1	1		92– 93
88– 91	2	2	2	3	2		2			1	1	2	6	1	88– 91
84– 87	2		5	3	4					4	3	1	6	1	84– 87
79– 83	4	4	11	8	8	1		2		7	7	3	5	1	79– 83
73– 78	5	5	5	10	5	3		7	5	5	8	4	4	2	73– 78
66– 72	7	15	17	9	11	7	3	5	14	12	6	11	6	5	66– 72
58– 65	15	22	16	17	22	20	19	18	15	14	20	13	9	8	58– 65
50– 57	18	20	20	20	22	24	18	20	18	31	20	15	8	23	50– 57
42– 49	23	22	15	15	12	20	46	29	28	11	19	17	9	25	42– 49
34– 41	15	12	10	8	12	25	22	25	23	21	9	19	3	17	34– 41
27– 33	15	11	11	18	14	17	14	14	17	11	13	5	5	17	27– 33
21– 26	14	4	9	6	5	6	6	5	5	6	6	5	1	13	21– 26
16– 20	8	2	3	1	2	4	1	2	2	4	4	1		4	16– 20
12– 15	3	3	1	4	3	2	1	2	1		1	2		2	12– 15
8– 11		1		1		1	1	1	2	2	1	3	1		8– 11
6– 7				1	1						1				6– 7
4– 5		1			1			2		1					4– 5
2– 3	1	2			1	1		1	2		2				2– 3
1						1									1
TOTAL...	132	126	125	126	125	133	133	133	133	130	121	102	67	119	

Distributions of college sophomore averages. The sophomore means of all colleges for which data were available are here distributed in terms of national sophomore percentiles. The percentile scale has been altered as in Fig. 151, so that the intervals correspond approximately to a sigma scale. The vertical distances are therefore roughly comparable.

FIG. 152



Comparison of professional goal groups. Graphs of means on indicated tests of college sophomores who reported their professional goals. The averages are graphed in terms of national sophomore percentiles arranged as in Fig. 151.

FIG. 153

Comparison of Professional Goal Groups

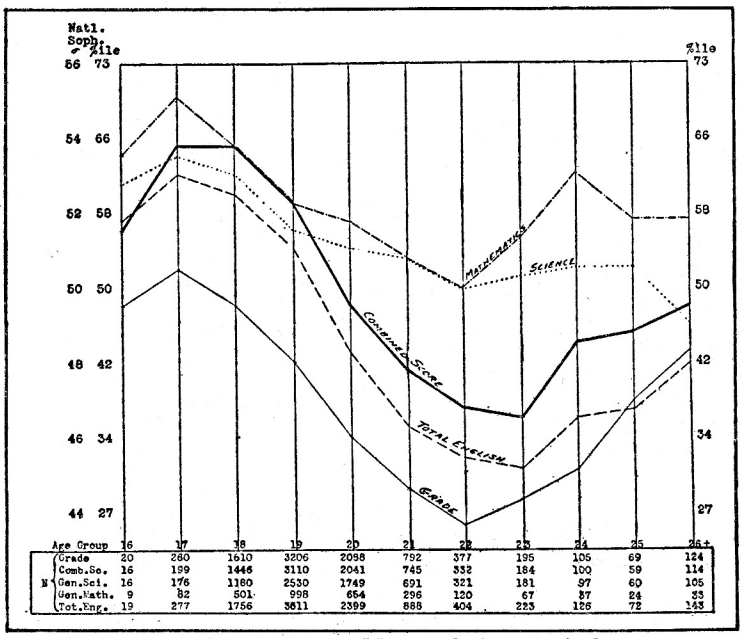
The average of each professional goal group on each test was calculated in the same way as the college averages of Fig. 152. Some of the professional goal averages are shown graphically in Fig. 153.

Fig. 153 affords several interesting contrasts and parallelisms. The lines connecting the averages of the medical and agricultural aspirants are practically parallel throughout, but the medical averages are roughly one sigma above the agriculture averages throughout. A general parallelism obtains between the lines for engineers and architects, except that the architects are considerably below the engineers in mathematics, and very much below in general science. In contrast with these groups, the journalists are relatively high in spelling, English, and General Culture, and mediocre in General Science and General Mathematics. Unlike all other groups, the law and teaching group lines hold a generally mediocre level across the chart, the law group being superior to the teaching group on all tests except spelling. The relatively smaller numbers of students taking the mathematics test suggest caution in interpreting the averages graphed at the extreme right of the chart.

Comparison of Age Groups

The average of each age group on each test was tabulated in the same manner, with the results shown in Fig. 154 for indicated variables.

Fig. 154 shows the familiar negative correlation between chronological age



	Age Group	16	17	18	19	20	21	22	23	24	25	26+
N	Grade	20	260	1610	3206	2098	792	377	195	105	69	124
	Comb.Sc.	16	199	1446	3110	2041	745	332	184	100	59	114
	Gen.Sci.	16	176	1180	2530	1749	691	321	181	97	60	105
	Gen.Math.	9	82	501	998	654	296	120	67	37	24	33
	Tot.Eng.	19	277	1756	3611	2399	885	404	223	126	72	143

Comparison of age groups. Means of chronological age groups of sophomores on indicated variables, graphed in terms of national sophomore percentiles arranged as in Fig. 151. Since the national distributions show varying degrees of positive and negative skewness, the means as here graphed appear too high for some variables and too low for others. However, it is the direction of the lines, rather than their height on the chart, that is significant here.

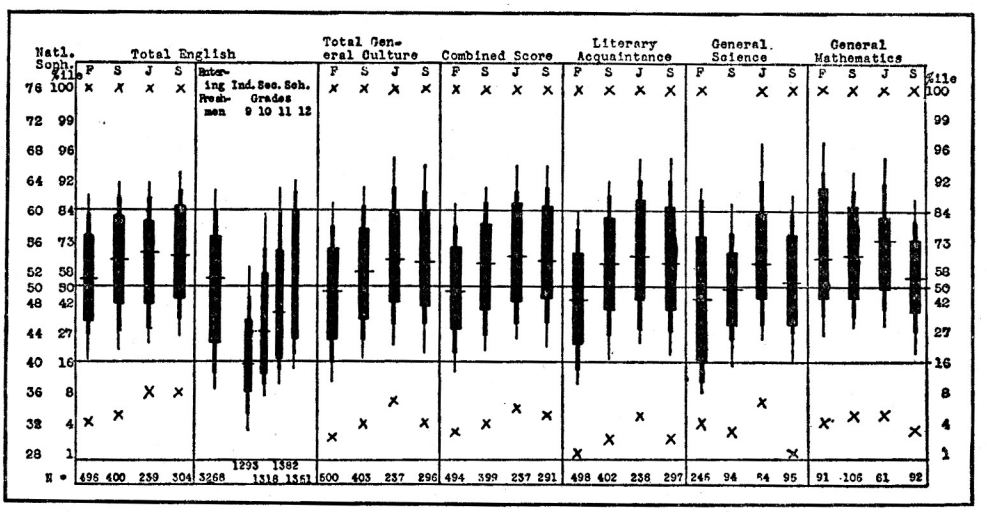
FIG. 154

and tested achievement. The negative correlation is fairly consistent for all variables from age 17 to 23, after which the relation becomes slightly positive; but the relation between age and average scores in General Science and General Mathematics is not far above zero throughout.

In this chart means are graphed in terms of national percentiles, and since the national distributions show varying degrees of positive and negative skewness, the lines connecting the averages of the different tests are rather widely separated, some appearing too high and some too low, according to the degree and direction of skewness. Similar but less obvious discrepancies appear in some of the other charts. Throughout this report an effort has been made to make all comparisons in terms of national sophomore percentiles, partly because of the more widespread familiarity with the percentile scale, and partly because of the lesser expense of preparing the report in this way. In calculating the averages of sub-groups, as of a college, or an age or professional group, it has been less expensive and more expeditious to calculate means rather than medians, hence the unusual procedure of charting and tabulating means in terms of percentiles, arranged to approximate a sigma scale, as in Fig. 151. However, the apparent distortion would have been as great if we had derived percentile from sigma scales, instead of the reverse.

Overlapping of College Classes

Five of the colleges that participated in the 1933 college testing program gave the sophomore tests to the pupils in all four college classes. This provided



Comparison of college classes. Graphs of scores on indicated tests of freshmen, sophomores, juniors, and seniors in the five colleges that tested all four classes. The class percentiles are graphed in terms of national sophomore percentiles arranged as in Fig. 151. All available cases on each test have been included. Varying numbers of the five colleges either omitted or made optional the General Science and General Mathematics tests in one or more of the classes; hence the indications from these tests should be taken with caution.

For comparative purposes, the distributions of comparable English test scores of entering college freshmen and of ninth, tenth, eleventh, and twelfth grade classes in independent secondary schools are graphed alongside the English test graphs of the college classes.

FIG. 155

an opportunity for comparing the freshman, sophomore, junior, and senior classes in these colleges with respect to achievement as measured by the tests. Distributions of the scores of each of the classes were easily secured by means of the punched cards and Hollerith machines. These distributions were graphed with the results shown in Fig. 155.

In general the class medians rise from freshman to junior classes, but the senior median is lower in general than the junior median, and in mathematics is lower even than the freshman median. On the English test the senior median recedes from the junior median less than on any other test, but even this slight recession is in strong contrast with the large advance made by the twelfth over the eleventh grade in independent secondary schools.

Of far greater significance, however, is the fact that even the largest differences in medians are small in comparison with the variability of the classes, and the further fact that the variability is approximately equal in all classes. In a basic subject matter such as English there are about as many very good students in the freshman as in the senior class, and nearly as many very poor students in the senior as in the freshman college class. The near-equality of the class medians might appear acceptable if the senior distribution were truncated at the bottom. The presence in the senior class as in the freshman class of nearly the same proportion of students below the tenth grade median for independent schools is enough to give one pause; and the fact can hardly be explained except on the grounds that time-serving rather than achievement furnishes the basis of promotion from freshman to senior class. It is more than probable that these students achieve social and some intellectual values in passing from the freshman to the senior class; but it seems clear that whatever the nature of these values may be, they are not associated with or dependent upon the type of literacy measured by the English test used in this program. Nearly a third of the college seniors in these five colleges are below the median of the freshmen, more than a fourth of the seniors are below the twelfth grade independent school median, and more than 10 per cent of the seniors are below the tenth grade median. On all the tests between one-third and one-fourth of the upper classes are below the freshman median, and equal proportions of the freshmen are above the highest upper class median, with approximately equal numbers of extremely good and poor students in each of the four classes.

Conclusion

The tables and charts described above are merely illustrative of the many ways in which the college test data were analyzed and studied with the aid of the Hollerith machines, with a maximum of accuracy and expeditiousness and a minimum of expense. It is obvious to anyone who has had experience in dealing with similar masses of data that even the analyses which have been presented above would be prohibitive in expense and time if they had to be done by hand methods. The adaptability of the punched card system for analyzing large masses of data is of particular importance to institu-

tions and groups of institutions that are too small to have their own Hollerith machines, because it is entirely feasible for such institutions or groups to punch their own cards at small expense and have the cards sorted and tabulated at Hollerith service bureaus which are now fairly well scattered over the entire world, in university research departments, and in business establishments.

PART V

Applications in Psychology and Educational Research

CHAPTER III

Analysis of High School Test Results

By

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ELECTRIC tabulating machinery for years has played an important part in the growth and development of large-scale testing projects. An outstanding example of its usefulness is its application in connection with the Iowa Every-Pupil Testing Program which has just completed its sixth year of continuous operation.

The Iowa Every-Pupil Testing Program is a coöperative, regional testing project whose fundamental purposes are to provide superior instruments for the measurement of educational achievement, to encourage better scholarship, and to accelerate improvement in the content and methods of high school instruction.

The project annually involves the administration of a battery of objective achievement examinations in several hundred high schools in Iowa and in neighboring states. These tests are given on the same day, under carefully standardized and uniform conditions, to every pupil enrolled in each of the subjects tested. Seventeen of the more fundamental subjects in grades nine to twelve are included, and a sixty-minute test is given in each.

The Iowa Every-Pupil Testing Program embodies all of the elements essential to the production of test materials of the kind needed. It is an annual coöperative program conducted for schools operating under relatively homogeneous conditions in a restricted geographical area; all materials are expertly constructed on a uniform basis under central supervision, resulting in high consistency in quality and in form from subject to subject; all materials are revised annually in order to keep them intimately related to the instructional programs in the schools and to keep them abreast of recent technical advances in test construction; norms are simultaneously established for all tests on the same group of pupils and schools, resulting in high comparability from subject

* Part of the material in this chapter has been taken from the author's pamphlet, "The Iowa Every-Pupil Achievement Testing Program," Bulletin of the State University of Iowa, new series No. 716, December 2, 1933, 22 pp., and from the summary report of results of the Sixth Annual Iowa Every-Pupil Testing Program of May 8, 1934. For further reference see "The Every-Pupil Tests in the Social Studies," "The Every-Pupil Tests in English," "The Every-Pupil Tests in the Sciences," and "The Every-Pupil Tests in Mathematics," which may be obtained upon request from The State University of Iowa.

to subject; and the very large numbers of pupils and schools involved make possible the establishment of specialized and localized norms far more reliable and meaningful than those provided for the usual standardized achievement test, including separate norms for schools in separate enrollment groups, separate norms for pupils at different levels of general intelligence, and norms for a single composite measure established upon the results for all pupils in all subjects in each participating school. The Every-Pupil Testing Program furthermore, is distinguished by unusual promptness in the reporting of results back to the schools—a promptness which is made possible by the extensive electric tabulating equipment in the University Statistical Service Bureau. A complete summary of the results of the entire testing program and of norms on all tests is distributed to each school within two weeks after the administration of the tests.

Of particular importance is the "Confidential Report of Results" for his own school which is sent to each superintendent or principal (see Figs. 156 and 158).

Column 6 in this report (Fig. 156) shows the total number of schools that administered each of the tests indicated to the left of the report. Column 7 tells the school in question how its average score in each subject ranks among the averages of all other schools participating in the subject. For example, the figure "9" in column 7 opposite algebra indicates that the algebra average for the school in question was 9th from the top in the distribution of algebra averages for the 123 schools (column 6) administering this test. The lowest possible rank in algebra is, of course, 123.

Because of the fact that the average scores on the different tests are originally measured in different units they must be expressed in terms of the same standard unit before comparisons can be made between different subjects or before a composite measure of performance may be computed for all subjects. For these purposes, each of the averages in column 2 has been expressed as a *T-Score* in column 5. The T-Scores represent the best basis for making comparisons between average performances in different subjects in the same school.

It would, of course, be outside the scope of this paper to show in full all of the dozens of tables that are prepared to show in detail the results of each testing program. A few must, therefore, suffice (see tables A, B, C, and D, Fig. 157.

It is interesting to note that in the preparation of the reports as well as of the tables, all hand transcriptions and computations of data are entirely eliminated. The tables from which the summary reports are typed are turned out by the printing tabulator in almost exactly the same form in which they are reproduced. The confidential reports are directly prepared on the alphabetic printing tabulator, again eliminating all of the laborious transcriptions and typing that had previously been necessary in the compilation of such reports.

The Every-Pupil Testing Program, therefore, represents a type of testing project which differs very significantly from, and is hardly comparable with,

(Continued on page 223)

1934 - Iowa Every-Pupil Testing Program - 1934

CONFIDENTIAL REPORT

of

Performance on the 1934 Iowa Every-Pupil Achievement Tests

in Relation to Intelligence of Pupils as Measured by the American Council Psychological Examination

SAMPLE COPY

High School

Subject	1 Number of Pupils who took the Every Pupil Test and the Psychology Exam.	2 Average Score of These Pupils on the Every Pupil Test	3 Average Score of These Pupils on the Psychology Exam.	4 "Expected" Average on the Every Pupil Test	5 Corrected T-Score for Average on Every Pupil Test	6 Number of Schools	7 Rank based on Corrected T-Scores	8 Rank based on actual average
ALGEBRA NINTH YEAR	88	19.4	80.4	13.0	66	123	9	21
GENERAL SCIENCE	83	42.2	74.8	39.6	56	107	26	63
LATIN FIRST YEAR	24	53.3	9.93	46.1	55	67	16	39
ENGLISH CORR 9	99	87.7	77.1	52.8	74	127	2	13
PLANE GEOMETRY	79	14.5	117.4	13.2	54	119	30	30
LATIN SECOND YEAR	15	92.2	120.1	81.9	54	57	16	24
ENGLISH CORR 10	95	97.6	106.5	80.7	60	125	20	20
WORLD HISTORY	100	37.8	106.0	37.8	50	101	55	48
AMERICAN HISTORY	67	52.6	125.8	45.3	67	86	5	4
AMERICAN LITERATURE	52	91.4	125.1	84.8	57	81	12	10
ENGLISH CORR 11	90	99.4	118.3	88.6	56	118	28	27
PHYSICS	62	35.3	129.8	35.6	49	104	55	43
AMERICAN GOVERNMENT	17	57.5	121.4	49.6	65	77	3	6
ENGLISH LITERATURE	76	87.8	123.5	81.9	58	83	17	16
ENGLISH CORR 12	88	83.7	116.5	84.3	50	119	56	72
COMPOSITE SCORE					58.282	129	13	

FIG. 156

How to Read Tables on Opposite Page

Table A

This table shows the distribution of *average* scores in algebra for the schools in each enrollment classification (columns A, B, C, and D) and for all participating schools (last column). For example, 3 schools in Class A earned an average score between 16.8 and 18.19, 1 school earned an average score between 15.4 and 16.79, etc. The numbers in parentheses indicate the frequencies for schools located outside of Iowa. These schools administered the algebra test under exactly the same conditions as the Iowa schools. As far as individual subjects are concerned their scores are strictly comparable with those from the Iowa schools, and are therefore included in the tabulations for each individual test. The numbers to the left in each column are, in each case, *inclusive of* the numbers in parentheses. For example, we see that 3 Class A schools earned an average score of 16.8 to 18.19. Of these 3 schools, 2 were out-of-state schools. To secure the number of Iowa schools in any one interval, then, we must subtract the number in parentheses from the number to the left in the same column. The figures opposite *N* in each column represent the total number of *schools* tabulated in that column. The numbers in parentheses again have the same significance. For example, out of the 20 schools entered in Class A, 6 were out of the state. The figures opposite A.M. (Arithmetic Mean) represent the *average* scores earned by all schools in each group. These averages are based upon the *total* group, out-of-state schools included. The relationship between achievement and size of school is indicated by these figures. In general, the best average performance on each test was secured in the Class A schools. The figure opposite S.D. (Standard Deviation) in the last column is a measure of variability in school averages for all schools taking this test. The standard deviation may be roughly described as the distance which when measured off on either side of the general average will include approximately the middle two-thirds of the individual averages in the distribution. This measure is used in transmuting average scores into T-score units.

Table B

This table is derived from the last column in Table A. It shows the value of the average score which exceeded that of a given per cent of all schools participating in that subject. For example, to exceed the average scores of 35% of *all* schools, a school must make an average score of 12.19. (The 99th and 1st percentiles represent the highest and lowest averages made in each group.) This table should not be confused with Table D. Table B shows how the school ranks as a school; Table D is used to interpret individual *pupil* performance. Any school desiring a more accurate percentile value for its own average score can obtain it by following the directions for using the Confidential Report. The percentile standing of your school in your own enrollment classification can also be computed from the Confidential Report. (Table B is based upon *all* schools taking the test, including competitive and non-competitive, Iowa and out-of-state schools.)

Table C

This table is similar to Table A, except that it distributes individual pupil scores instead of school averages. For example, 10 pupils in Class A schools earned a score between 40 and 43 (column A); 2390 pupils in Class A schools took the algebra test, and made an average score of 15.38. The averages in Table C will differ slightly from those in Table A, since in the first table the *school* was considered a unit, and the small school carried just as much weight as the large one. The averages in Table C are slightly superior to those in Table A for the purpose of comparing performances in the different enrollment classifications.

Table D

This table disregards enrollment classifications, and deals with all pupils who took the algebra test. According to this table, any pupil who scored from 40 to 65 inclusive was included in the 100th percentile, or in the highest 1% of the total group. Any pupil scoring from 37 to 39 inclusive ranked in the 99th percentile, etc. To transform a pupil's score into a percentile, find the interval in the "Score" column which includes his score, and take the corresponding value in the "%-ile" column to the left. This table should be used for purposes of comparing a pupil's performance from subject to subject or from year to year. The percentile derived from this table is that recommended for inclusion in the pupil's cumulative record form in the principal's office. The last entries in the table, opposite "H.S." and "L.S.," represent the highest and lowest scores, respectively, that were made by any pupil. In the case of algebra, 60 was the highest score earned, 0 the lowest.

A. Frequency Distribution of School Averages

School Average	Enrollment Group A	B	C	D	Total Group
32.2-up			1		1
30.8-32.19					
29.4-30.79				1	1
28.0-29.39					
26.6-27.99					
25.2-26.59		2	2	3	7
23.8-25.19			2	1 (1)	3 (1)
22.4-23.79			1	1	2
21.0-22.39		3		2	5
19.6-20.99	4 (1)	4	2	4	14 (1)
18.2-19.59	4 (1)	1	1	3	9 (1)
16.8-18.19	3 (2)	6 (1)	3	8	20 (3)
15.4-16.79	1	12 (2)	9	5	27 (2)
14.0-15.39	3	5 (1)	12	8	28 (1)
12.6-13.99	1	10 (2)	9	8	28 (2)
11.2-12.59	1	8	16 (1)	10 (1)	35 (2)
9.8-11.19	2 (1)	7	10	2	21 (1)
8.4- 9.79		4 (1)	7	7	18 (1)
7.0- 8.39	1 (1)	4 (1)	3	7	15 (2)
5.6- 6.99			3	1	4
4.2- 5.59			1		1
2.8- 4.19				2	2
N.	20 (6)	66 (8)	82 (1)	73 (2)	241 (17)
A.M.	16.17	14.47	13.75	14.43	14.35
S.D.					4.92

B. %-ile Table for School Averages

%-ile Rank	Total Group
99	41.13
95	23.80
90	20.69
85	18.97
80	17.83
75	17.12
70	16.14
65	15.70
60	15.13
55	14.47
50	13.84
45	13.25
40	12.65
35	12.19
30	11.75
25	11.11
20	10.49
15	9.19
10	8.56
5	7.50
1	3.11

C. Frequency Distribution of Pupil Scores

Pupil Score	Enrollment Group A	B	C	D	Total Group
60-65			1		1
56-59					
52-55	1		3		4
48-51	3	7	1	1	12
44-47	2	14	3	5	24
40-43	10	23	13	1	47
36-39	27	37	33	7	104
32-35	73	74	37	23	207
28-31	145	153	64	34	393
24-27	168	235	98	63	564
20-23	283	367	153	89	892
16-19	337	505	248	126	1216
12-15	455	633	356	147	1571
8-11	441	661	417	167	1686
4- 7	338	592	362	159	1451
0- 3	127	216	176	75	594
N.	2290	3515	1965	899	8769
A.M.	15.38	14.65	13.47	14.07	14.52

D. Percentile Table for Pupil Scores

%-ile	Score	%-ile	Score	%-ile	Score	%-ile	Score
100	40-	35	10				
99	37-39	31	9				
98	34-36	26	8				
97	33	21	7				
96	32	17	6				
95	31	13	5				
94	30	9	4				
93	29	6	3				
92	28	3	2				
91	27	2	1				
89	26	1	0				
88	25						
86	24	H.S.	60				
84	23	L.S.	0				
82	22						
79	21						
76	20						
73	19						
70	18						
67	17						
63	16						
59	15						
54	14						
50	13						
45	12						
40	11						

FIG. 157

1934—SIXTH ANNUAL IOWA EVERY-PUPIL TESTING PROGRAM—1934

CONFIDENTIAL REPORT OF RESULTS

SAMPLE COPY
(Name of School)

Enrollment Classification: C C Basis of Participation
(C=Competitive; N=Non-competitive)

SUBJECTS TESTED	1 Number of Pupils Tested in Subject	2 Average Score on Test	3 T-Score Equivalent of Average Score	4 Number of Schools in Same Enrollment Class Giving Same Test	5 Rank Among Schools in Same Enr. Class	6 Total Number of Schools Giving Same Test	7 Rank Among All Schools
ALGEBRA NINTH YEAR	36	25.44	72	82	3	241	9
GENERAL SCIENCE	35	49.40	60	76	13	196	31
LATIN FIRST YEAR	22	93.00	76	34	2	117	2
ENGLISH CORR 9	36	86.92	66	80	7	247	19
PLANE GEOMETRY	28	8.61	43	78	51	231	171
LATIN SECOND YEAR	21	149.19	73	25	1	111	3
BIOLOGY	17	69.24	59	33	4	118	22
ENGLISH CORR 10	26	109.65	67	82	2	245	6
AMERICAN LITERATURE	27	93.33	62	58	3	157	13
ENGLISH CORR 11	29	99.55	61	79	10	238	39
PHYSICS	27	49.22	70	74	2	203	8
AMERICAN GOVERNMENT	30	65.97	80	57	1	156	1
ENGLISH LITERATURE	14	95.07	65	55	6	155	15
ENGLISH CORR 12	29	95.45	55	78	24	235	81
COMPOSITE SCORE		64.881		71	1	190	1

NOTE: The composite measure at the bottom of column 2 is based upon the T-score values (col. 3) for the averages in the various subjects. This composite measure was computed as follows: each T-score in col. 3 was multiplied by the number (in col. 1) of pupils upon which it was based; these products were then added and their sum was divided by the sum of the numbers in col. 1. The T-score for each subject was thus *weighted* in proportion to the number of pupils tested in that subject. The numbers at the bottoms of cols. 4 and 6 include only Iowa schools that participated on the competitive basis, and the composite is ranked (bottom of cols. 5 and 7) only with reference to these schools. Schools participating on the non-competitive basis may evaluate their composite measure by comparison with the data in Table F on the last page of the Summary Report.

FIG. 158

any that could be independently devised in a single school system by using the scattered standardized tests now available elsewhere. To the school administrator or supervisor, this program is a unique source of important information about his own school. It furnishes him with a reliable means of evaluating the results of instruction in his school as compared to that in others; it provides a partial basis for checking the validity of the content taught; it helps him to discover those teachers on his staff who are most in need of supervisory aid, those subjects most in need of curriculum revision, and those pupils most in need of individual attention; it may be used to increase the reliability of the marks used for the promotion, demotion, and classification of pupils; it makes possible better educational guidance; and it gives him an indirect measure of the educational effectiveness of his own organization and administrative policies.

Special attention should be given to the advantages of continuous year-after-year participation in a program of this character. Periodic measurements of the comparable type provided by the Every-Pupil Testing Program will enable the schools to determine more objectively what progress they have made in the improvement of instruction, and will permit a better evaluation of changes in administrative and supervisory policies. Furthermore, the systematic cumulative recording, over a period of years, of the test results of individual pupils should provide a valuable aid in the long-time educational guidance and counselling of students. This latter use of comparable test results has, in fact, been recently acclaimed by certain leaders in the field of measurement as the most significant single outcome of the objective testing movement. In order to encourage further development of such guidance possibilities, the sponsors of this project intend to prepare an individual cumulative record form upon which Every-Pupil test data and other significant information concerning the pupil may be permanently recorded, and to distribute this form to the participating schools as soon as possible.

It may be noted finally that the Iowa Every-Pupil Testing Program presents a unique opportunity for educational research. Most of the educational agencies upon which we rely at present for research and experimentation are of relatively limited scope and facilities. They are adequately equipped only to tackle problems calling for intensive experimentation with or investigation of small groups of pupils, usually located in a single school or in a very small number of schools. Very few research organizations have the facilities to handle problems of the type in which the teacher or the school, rather than the pupil, is the basic unit, and in which achievement test data must be collected on a very large scale, not only from one hundred or so pupils, but from the pupils under one hundred or more teachers or in one hundred or more school systems. Many of our most pressing and crucial educational problems call for this latter extensive type of attack. The relationship between class size and academic achievement, between size and type of school organization and results achieved, or between such factors as the training and experience of teachers and the achievement of their pupils, for example, are problems that require the collection of data on such a wide scale as to render their treatment highly inexpedient, if not impossible, for the usual research agency.

As a result, many of our most fundamental problems have remained, not only unsolved, but practically untouched.

It is in just this type of situation that the Iowa Every-Pupil Testing Program serves its most useful function as a research agency. Collecting, as it does every year, achievement test data and related information from hundreds of school systems, from thousands of teachers, and from tens of thousands of high school pupils, it makes possible the investigation of many of these hitherto untouched problems at very little additional cost.

In these research studies again a number of valuable applications are made of the electric tabulating equipment. As a matter of fact, considering the large mass of data to be analyzed, many of these investigations would be absolutely impracticable if this equipment were not available. For example: Following each annual testing program a random sample of one thousand examination papers is taken from all those written in each subject and a detailed item analysis is made of the pupil responses. This analysis includes securing the percentage of correct responses on each item, the percentage of pupils selecting each of the various false responses to each of the recognition (multiple choice) items, as well as an index of discrimination or selectivity for each individual item. These analyses are extremely valuable in disclosing specific weaknesses in current instruction and in drawing attention to technical imperfections in the individual test items and suggest many specific improvements that might be made in tests to be built later. If these item analyses had to be done by hand methods, they would prove so time-consuming and expensive as to make them totally inexpedient.

These valuable by-products of a testing program in no way interefere with the more fundamental purposes of the project, and provide an unequalled opportunity for studying the factors affecting learning. The results of such research should contribute much to the establishment of a better and more effective learning environment.

PART V

Applications in Psychology and Educational Research

CHAPTER IV

The Scoring of Vocational Interest Tests

By

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MEN engaged in a particular occupation have been found to have a characteristic set of likes and dislikes which distinguish them from men following other professions. Scores on the Vocational Interest Blank** are a measure of how nearly a man's interests coincide with those of the average man successfully engaged in a certain occupation.

For the purposes of this test it is assumed that a man will be more effective in his vocational career if he is engaged in work that he likes than if he is forced to do a great many things that he dislikes. If he is given his own free will in the matter, it is apparent from surveys made at Stanford University that his general interest will, to a surprising extent, influence his choice of a career.

It will be some time before the validity of this test can be exactly determined. Results so far obtained show that the test has genuine merit.

The blank must be scored separately for each occupational scale. If scores, for example, are desired upon twenty-six of these occupations, it is necessary to score the blank twenty-six times.

In diagnosing a man's occupational interests the blank should be scored on many different scales, for in this way the interest pattern may be most clearly ascertained. This should be done with Hollerith equipment, as the labor of scoring all these scales by hand is excessive. (See section below on scoring the blank.) There are many cases, however, where a student is desirous of knowing which of two or at most three occupations he should enter. In such cases, the blank may be scored for these few occupations at less cost by hand.

As the twenty-six occupations may be classified into seven groups on the basis of interests, it is possible by scoring the blank for interest in seven occupations (each of which is fairly typical of a group) to ascertain a man's occupational interest with respect to these groups of occupations. These seven

* Part of the material in this paper has been taken from the author's recently published "Manual for Vocational Interest Blank," Stanford University Press.

** The first two of the eight pages of the Vocational Interest Blank are shown in Fig. 159.

occupations are physicist (Group I), lawyer (Group IIa), life insurance salesman (Group IIb), teacher (Group IIIa), Y.M.C.A. Secretary (Group IIIb), office man (Group IV), and certified public accountant (Group V),

Occupational Interests That Can Be Determined by the Test

Accountant	Engineer	Psychologist
Advertiser	Farmer	Purchasing Agent
Architect	Journalist (newspaper editor)	School Teacher and Administrator
Artist*	Lawyer	Vacuum Cleaner Salesman
Boy Scout Master	Life Insurance Salesman	Y.M.C.A. General Secretary
Carpenter*	Mathematician	Y.M.C.A. Physical Director
Certified Public Accountant (revised)	Minister	Interest Maturity*
Chemist	Office Clerk	
City School Superintendent	Personnel Manager	
Dentist	Physician and Surgeon	
	Physicist	

Scoring the Blank

The entire blank must be scored for each occupational interest, using a different scoring scale in each case. A scoring scale (stencil) includes nine slips of cardboard, corresponding to the nine parts of the test. On each slip are printed three columns of figures. To illustrate this and the method of using the scale, the first five items on the blank are given below and opposite them the scores which appear on the scoring scale for lawyer interest.

Actor.....	L	I	D	1	-1	0
Advertiser.....	L	I	D	-7	0	4
Architect.....	L	I	D	-2	0	3
Army Officer.....	L	I	D	1	-2	0
Artist.....	L	I	D	-2	-1	3

If a person should circle L opposite all five of these items he would be given the following scores: 1, -7, -2, 1, and -2, totaling -9. On the basis of these five items he does not have the interests of a lawyer. To score the blank, then, one must ascertain the 420 scores assigned to the L's, I's, and D's that have been circled and then total them, observing the algebraic signs.

There are two methods of scoring by means of the Hollerith Machines. The first of these can be applied by anyone having a standard sorting and tabulating machine. The second requires a special attachment for the tabulating machine which was suggested and outlined by Dr. Ben D. Wood, Columbia University, and designed by Mr. Richard Warren and engineers of the IBM. This attachment can be obtained from the Tabulating Machine Division of the

* Those starred have just been published. Scales for policeman and masculinity-feminity will be published shortly.

Parts Ia and Ib. *Occupations.* Indicate after each occupation listed below whether you would like that kind of work or not. Disregard considerations of salary, social standing, future advancement, etc. Consider only whether you would like to do what is involved in the occupation.

Draw a circle around L if you like that kind of work.

Draw a circle around I if you are indifferent to that kind of work.

Draw a circle around D if you dislike that kind of work.

Work rapidly. Your first impressions are desired here. Answer all the items. Many of the seemingly trivial and irrelevant items are very useful in diagnosing your real attitude.

Actor (not movie)	L	I	D	Lawyer, Criminal	L	I	D
Advertiser	L	I	D	Lawyer, Corporation	L	I	D
Architect	L	I	D	Librarian	L	I	D
Army Officer	L	I	D	Life Insurance Salesman	L	I	D
Artist	L	I	D	Locomotive Engineer	L	I	D
Astronomer	L	I	D	Machinist	L	I	D
Athletic Director	L	I	D	Magazine Writer	L	I	D
Auctioneer	L	I	D	Manufacturer	L	I	D
Author of novel	L	I	D	Marine Engineer	L	I	D
Author of technical book	L	I	D	Mechanical Engineer	L	I	D
Auto Salesman	L	I	D	Mining Superintendent	L	I	D
Auto Racer	L	I	D	Musician	L	I	D
Auto Repairman	L	I	D	Music Teacher	L	I	D
Aviator	L	I	D	Office Clerk	L	I	D
Bank Teller	L	I	D	Office Manager	L	I	D
Bookkeeper	L	I	D	Orchestra Conductor	L	I	D
Building Contractor	L	I	D	Pharmacist	L	I	D
Buyer of merchandise	L	I	D	Photo Engraver	L	I	D
Carpenter	L	I	D	Physician	L	I	D
Cartoonist	L	I	D	Playground Director	L	I	D
Cashier in bank	L	I	D	Poet	L	I	D
Certified Public Accountant	L	I	D	Politician	L	I	D
Chemist	L	I	D	Printer	L	I	D
Civil Engineer	L	I	D	Private Secretary	L	I	D
Civil Service Employee	L	I	D	Railway Conductor	L	I	D
Clergyman	L	I	D	Rancher	L	I	D
College Professor	L	I	D	Real Estate Salesman	L	I	D
Consul	L	I	D	Reporter, general	L	I	D
Dentist	L	I	D	Reporter, sporting page	L	I	D
Draftsman	L	I	D	Retailer	L	I	D
Editor	L	I	D	Sales Manager	L	I	D
Electrical Engineer	L	I	D	School Teacher	L	I	D
Employment Manager	L	I	D	Scientific Research Worker	L	I	D
Explorer	L	I	D	Sculptor	L	I	D
Factory Manager	L	I	D	Secretary, Chamber of Commerce	L	I	D
Factory Worker	L	I	D	Secret Service Man	L	I	D
Farmer	L	I	D	Ship Officer	L	I	D
Floorwalker	L	I	D	Shop Foreman	L	I	D
Florist	L	I	D	Social Worker	L	I	D
Foreign Correspondent	L	I	D	Specialty Salesman	L	I	D
Governor of a State	L	I	D	Statistician	L	I	D
Hotel Keeper or Manager	L	I	D	Stock Broker	L	I	D
Interior Decorator	L	I	D	Surgeon	L	I	D
Interpreter	L	I	D	Toolmaker	L	I	D
Inventor	L	I	D	Traveling Salesman	L	I	D
Jeweler	L	I	D	Typist	L	I	D
Judge	L	I	D	Undertaker	L	I	D
Labor Arbitrator	L	I	D	Watchmaker	L	I	D
Laboratory Technician	L	I	D	Wholesaler	L	I	D
Landscape Gardener	L	I	D	Worker in Y.M.C.A., K. of C., etc.	L	I	D

Part II. *Amusements.* Indicate in the same manner as in Part I whether you like the following or not. If in doubt, consider your most frequent attitude. *Work rapidly.* Do not think over various possibilities. Record your first impression.

Golf	L	I	D
Fishing	L	I	D
Hunting	L	I	D
Tennis	L	I	D
Driving an automobile	L	I	D
Taking long walks	L	I	D
Boxing	L	I	D
Checkers	L	I	D
Chess	L	I	D
Poker	L	I	D
Bridge	L	I	D
Solitaire	L	I	D
Billiards	L	I	D
Observing birds (nature study)	L	I	D
Solving mechanical puzzles	L	I	D
Playing a musical instrument	L	I	D
Performing sleight-of-hand tricks	L	I	D
Collecting postage stamps	L	I	D
Drilling in a company	L	I	D
Chopping wood	L	I	D
Amusement parks	L	I	D
Picnics	L	I	D
Excursions	L	I	D
Smokers	L	I	D
"Rough house" initiations	L	I	D
Conventions	L	I	D
Full-dress affairs	L	I	D
Auctions	L	I	D
Fortune tellers	L	I	D
Animal zoos	L	I	D
Art galleries	L	I	D
Museums	L	I	D
Vaudeville	L	I	D
Musical comedy	L	I	D
Symphony concerts	L	I	D
Pet canaries	L	I	D
Pet monkeys	L	I	D
Snakes	L	I	D
Sporting pages	L	I	D
Poetry	L	I	D
Detective stories	L	I	D
"Literary Digest"	L	I	D
"Life"	L	I	D
"New Republic"	L	I	D
"System"	L	I	D
"National Geographic Magazine"	L	I	D
"American Magazine"	L	I	D
"Popular Mechanics"	L	I	D
"Atlantic Monthly"	L	I	D
"Arts and Crafts"	L	I	D
Cowboy movies	L	I	D
Educational movies	L	I	D
Travel movies	L	I	D
Social problem movies	L	I	D

Part III. *School Subjects.* Indicate as in Part II your interest when in school.

Algebra	L	I	D
Agriculture	L	I	D
Arithmetic	L	I	D
Art	L	I	D
Bible Study	L	I	D
Bookkeeping	L	I	D
Botany	L	I	D
Calculus	L	I	D
Chemistry	L	I	D
Civics	L	I	D
Dramatics	L	I	D
Economics	L	I	D
English Composition	L	I	D
Geography	L	I	D
Geology	L	I	D
Geometry	L	I	D
History	L	I	D
Languages, ancient	L	I	D
Languages, modern	L	I	D
Literature	L	I	D
Mathematics	L	I	D
Manual Training	L	I	D
Mechanical Drawing	L	I	D
Military Drill	L	I	D
Music	L	I	D
Nature Study	L	I	D
Penmanship	L	I	D
Philosophy	L	I	D
Physical Training	L	I	D
Physics	L	I	D
Psychology	L	I	D
Physiology	L	I	D
Public Speaking	L	I	D
Shop work	L	I	D
Shorthand	L	I	D
Sociology	L	I	D
Spelling	L	I	D
Typewriting	L	I	D
Zoölogy	L	I	D

FIG. 159—The first two pages of the Strong Vocational Interest Blank

International Business Machines Corporation.** The latter method, which is considerably faster, will appeal chiefly to those who have many blanks to score.

The two procedures are as follows:

First Method (standard machines)

A Hollerith card is provided for liking, another for indifference, and another for disliking each of the 420 items, making 1,260 cards in all. Each of these cards has punched on it the appropriate scores for all the occupational scales. The scores for each item have been predetermined by percentages, being weighted according to the responses of a criterion group of men successfully engaged in a particular occupation. The weights range from 0 to 30.* When a blank is scored, cards are taken from the file corresponding to the circlings on the blank. (Cards can be "pulled" for approximately five blanks an hour.) The cards are then run through the tabulator and totals for nine scales recorded. They must be run through twice more to obtain the totals for twenty-seven scales. When this has been accomplished, the cards are run through the sorter and finally returned to the file to be used again.

At Stanford we have found twenty-five duplicates sufficient, thus employing 31,500 cards in all. The cards are kept in open files 15″x10¾″ with two partitions 15″ x 4″ that run longitudinally. Heavy cardboard dividers keep the cards separated. These are deeply notched so as to fit over the two partitions. The assistant pulls out with his right hand the like, indifferent, or dislike card, according as the blank is marked opposite item one, and places it on the table, while with his left hand he pulls the first divider forward, exposing the cards for item two. This is repeated for the 420 items.

Second Method (special attachment)**

A tabulating card (See Fig. 160) is provided for each question, there being 420 complete to a stack. Each card is pre-punched serially, having in addition the appropriate like, indifferent, and dislike scores for nine occupations. To realize results on twenty-seven occupations, there must be three sets of 420 cards each.

The operator tabulates by means of a three-key control box which is set on the reading board of the printer machine. Each button is designated as a like, indifferent, or dislike key respectively. By running the eye down the blank and depressing one of three keys for each answer, the complete like, dislike, or indifferent scores for nine occupations are added into the five counters of the machine through the medium of three-field selection relays. The card count and one occupational score is tabulated in Counter No. 1. All other counters each carry scores for two occupations.

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* As the less expensive types of Hollerith equipment cannot conveniently handle negative weights, 15 is added to the weights as printed on the Scales, published by the Stanford University Press, so that all weights will be positive and will range from 0 to 30 instead of from −15 to +15.

** See Fig. 22, page 19.

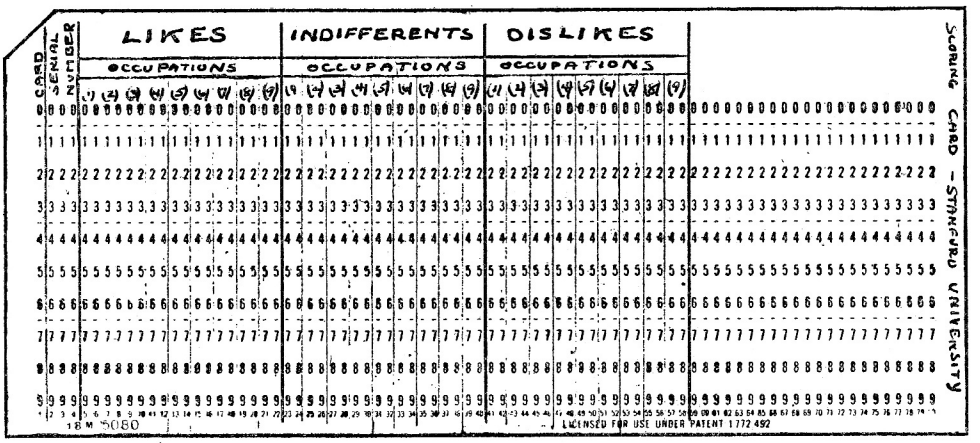

FIG. 160*

There is no machine wiring necessary for the scoring. The set-up is ready for use by merely turning a switch which deviates the tabulator from normal. By test under actual working conditions the average tabulation speed is about 130 cards per minute running time. Approximately 32 blanks covering 27 occupations can be completed, scored and registered in an eight hour day.

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* The card above was sketched to illustrate the column arrangement for punching. The cards actually used are standard blank forms. (*IBM* 5080.)

PART V

Applications in Psychology and Educational Research

CHAPTER V

Analysis of Intelligence Test Scores

(In connection with the revision of the Stanford-Binet)

By

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DR. MAUD A. MERRILL

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IN recent years tabulating machine equipment has been extremely useful in facilitating statistical work in the standardization of various kinds of psychological and educational group tests. Its value for the standardization of an individual intelligence scale of the mental age type has had no opportunity to become established.

The Revision of the Stanford-Binet has accumulated data over a period of five years which require extensive treatment. The individual tests must first be studied in order to eliminate those which are not satisfactory tests of intelligence. For this purpose we must determine whether a test increases rapidly and regularly in the percent passing it from year to year; and whether bright children have a higher degree of success on it than dull children. We also need to determine the age at which the test will be placed. It is important to know the effect upon the individual test of such factors as locality, rural versus urban environment, educational achievement, sex, etc. Each test must be correlated with each child's performance as a whole.

When the tests have been studied individually and the final selection made, they can be rearranged into a permanent scale. The total scores must then be converted into mental ages, and median mental age made to equal median chronological age for both forms. The two forms must be made comparable. In order to test the validity and reliability of the scale other factors must be investigated. The distribution of I. Q.'s must be found. It is essential to compare the intelligence level with the socio-economic level, with sex, location, school grade, and with scores made on other intelligence tests. The point of mental maturity must be determined. It is desirable to have some factor analysis. We must also compare the first form given a child with the second form given, as well as the same form given first against given second. Other reliability criteria must be applied. It is of value to have the data in such form that related studies can be made, such as investigation of the influence

of nationality background, sibling relationship, and the effect of different age-grade systems.

Having arranged two tentative forms of the scale, a sampling of children was secured in representative localities throughout the United States. About 3200 unselected children ranging in age from 18 months to 18 years were given both forms of the test, making a total of 6400 test blanks. After the scoring standards were established and the test blanks scored, all the necessary information was transferred to Hollerith cards. The tests, some 400 in number, were divided among 9 cards for form L and 8 cards for form M. Certain constant identifying data appear on each card, as well as on the master card. The average number of cards punched for each child is about 10, including the master card on which appear the constant identifying data, together with further individual data. Room is also left for punching in of successive scores as the scale needs shifting. No special card forms were printed, blank cards being found preferable for our purpose.

As a detailed example of the method of punching and coding, one card is illustrated, as well as the corresponding pages of the Stanford Revision Binet-Simon scale, Figs. 161 and 162.

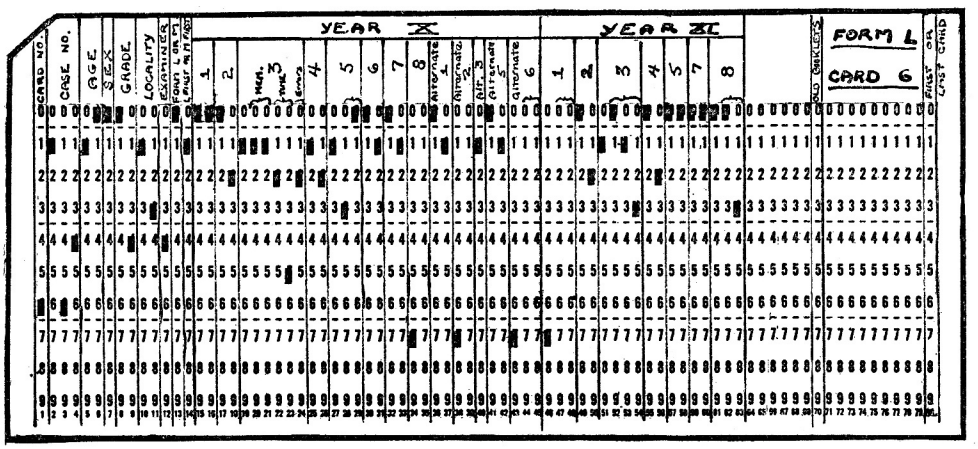

FIG. 161

Columns 2 through 12 are constant identifying data appearing on every card for this child, and were punched on the duplicating card punch. Column 1 indicates that this is Card number 6, which in the L series contains the tests grouped at Year X and XI. In Columns 2, 3, and 4 is punched the child's case number, which is further identified by the chronological age punched in columns 5 and 6. The age code used is as follows:

1½ years	—51	4 years	— 04	8 years	— 08
2	02	5	05	9	09
2½	52	5½	55	10	10
3	03	6	06	11	11,
3½	53	7	07	etc.	

Year X (Front Only)

1. Memory for Designs
   a. *b.*
2. Verbal Absurdities
   a.
   b
   c.
   d
   e

Reading and Report
Memories.....Time for reading ..... Mistakes.....
New York | September 5th. | —A fire | last night | burned | several houses | near the center | of the city | It took some time | to put it out. | The loss | was fifty thousand dollars, | and seventeen families | lost their homes. | In saving | a girl | who was asleep | in bed, | a fireman | was burned | on the hands.

4 Finding Reasons
   a.
   b

5 Word Naming

6 Clock Problems
   a. *b* *c.* *d*
7 Abstract Words
   a.
   b
   c
   d
   e

8 Comprehension (same as IX, 2)

Alternatives

1 Orientation: Form
   a. *b.*
2 Rhymes—Old Form (same as IX, Alt. 1)

(*Continued on next page*)

Year XI

1. Vocabulary (same as VIII, 1)
2. Dissected Sentences
   a. T.....
   b. T.....
   c. T.....
3. Pictures (same as V—6, 3)
4. Similarities: Three Things
   a.
   b.
   c.
   d.
   e.
5. Reversed Digits
   a. 8-1-3-7-9.... *b.* 6-9-5-8-2.... *c.* 5-2-9-4-1....
6. Comprehension (same as IX, 2)
7. Verbal Absurdities
   a.
   b.
   c.
8. Abstract Words
   a.
   b.
   c.
   d.
   e

Alternatives

1. Similarities: Three Things
   a.
   b.
   c.

FIG. 162—Sample pages from Stanford Revision Binet-Simon Intelligence Tests

The sex is punched 0 for boys, 1 for girls, in Column 7.
Grade, Columns 8 and 9, is coded:

00—Kindergarten and Pre-Primary
01—First Grade and Primer
02—Second Grade, and similarly through 08—Eighth Grade
09—Ninth Grade, or First Year H.S., or last year Junior High School
10, 11, 12—second, third, or fourth year H.S.
14—Preschool
15—Nursery School, Day Nursery
16—Special Class, Opportunity Room, etc.
17—Part-time School, Continuation School
18—Out of school with H.S. completed
19—Out of school without completing H.S.
20—Post-graduate work in H.S.

Columns 10 and 11 contain locality, from which can be obtained a rural vs. urban distribution, as well as locality. Coded:

00—San Francisco, California
01—Denver, Colorado
02—Richmond, Virginia
03—Atlee, Virginia
04—Kansas and Missouri (Urban)
05—Kansas and Missouri (Rural)
06—Kentucky
07—Indiana
08—New York City
09—White Plains, New York
10—Randolph, Vermont
11—Los Gatos, Calif. (Urban)
12—Minneapolis, Minnesota
13—Bloomington, Minnesota
14—Reno, Nevada
15—San Antonio, Texas
16—Redwood City, California
17—Los Gatos, Calif. (Rural)

Each of the seven examiners receives a code number appearing in Column 12. Column 13 indicates to which form (L—0, M—1) this card refers, giving a means for machine sorting of forms. Column 14 indicates whether this form was given the child first or second. Columns 15 through 45 cover the individual tests grouped under Year X, and Columns 46 through 63 the tests for Year XI. Under the test section of the card the first card allotted to a test is punched for the child's success or failure, coded:

0—test failed
1—test passed
7—test assumed failed, or a recurring test failed at this level
8—test assumed passed, or a recurring test passed at this level
9—spoiled or omitted test

The first column for each test is used in summing the child's individual total score. The following column or columns give the detailed information, largely coded, from which the study of the test itself is made. Much of this study of individual tests can be accomplished on the card counting sorter. The tabulator is used to get the data of the hundreds of item correlations necessary.

In Column 70 is punched a special code to designate an earlier form of the scale. Columns 71 to 79 inclusive are reserved for punching in total scores for L and M singly and combined, derived by printing the success columns on the printing tabulator. Column 80 is used to facilitate the assembling of all of the cards of an individual child. That card in the series which represents the child's first card is punched 1, and the last card for that child is punched 9. If a child's range is so limited as to be covered on one card, that one card is punched 5.

These data have been thus recorded on 30,000 cards, each being verified as soon as punched.

PART V

Applications in Psychology and Educational Research

CHAPTER VI

The Scoring and Analysis of Free Association Tests

By

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THE free association test consists of a stimulus word shown or spoken to the subject who responds, generally by writing, with the first word that comes to his mind. The particular test used had 198 stimulus words and was given to junior high school pupils. Such responses may be investigated with reference to their connection with any ability or character trait for which an independent measure is available. Eight such independent measures for some 800 junior high school pupils were available in this study, namely: Courtesy, Fair Play, Honesty, Loyalty, Poise, Mastery, Regard for Property Rights, and School Drive. The purpose of the study was to determine how responses were to be scored in order to obtain measures of these eight traits based upon the 198 responses given by each pupil of this group, and second, to use the appraisals of responses thus obtained as a scoring scheme so that new pupils could be scored for these eight traits upon the basis of their responses.

Since the number of different responses to a single stimulus word for the sample of nearly 800 ran from about 40 to 80, with an average of about 50, it would seem that 10,000 (50 x 200 = 10,000) different responses had to be investigated, and that to each response it was necessary to attach 8 different trait scores. This is a formidable undertaking by any means. With the aid of 80 column Hollerith cards, and by grouping certain similar responses, and grouping into a "unique" class all responses given but once, it was found possible to reduce the number of responses investigated for each stimulus word to 46 or less. For each stimulus word these were numbered, and the number of the response punched in two columns corresponding to the stimulus word. Upon the same card in designated columns were punched the eight character trait scores. The sample reproduced on the following page, Fig. 163, is illustrative. The first six columns contain general information as to age, school grade, etc., the next eight contain the eight character trait scores, and the next sixty-six contain the response numbers for responses to 33 stimulus words. Six such cards were used to provide for the entire record, the first 14 columns on the last five having been duplicated from the punchings on the first card by means of a duplicating punch. The edges of the six cards were colored with different inks to facilitate proper handling.

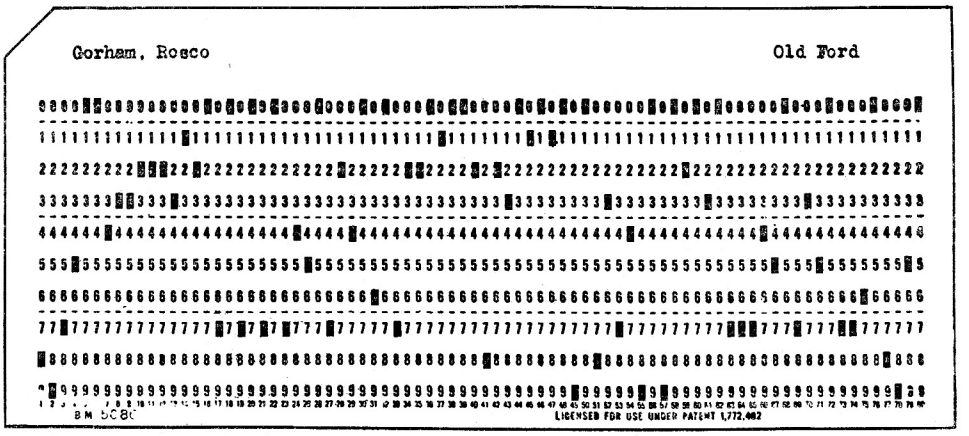

FIG. 163

To illustrate the procedure we may consider the punching in columns 15-16 corresponding to the response to the first stimulus word, which was "ride." The cards were sorted upon the basis of these two columns, and each pile run through a tabulation printer which recorded the sums of the scores separately on columns 6 to 14. For example (hypothetical), the pile giving the response "fast" to the stimulus "ride," consisting of 80 cards, is run through the tabulation printer, yielding totals for columns 6 to 14 of

430 384 295 314 184 411 255 284

and averages of

5.4 4.8 3.7 3.9 2.3 5.1 3.2 3.5

which values, after deducting the mean and making an allowance depending upon the number of cases giving the response, and retaining to a single digit, constitute the credits or scores attached to the response "fast" for the 8 character traits respectively. This illustrates the manner in which the scoring scheme was built up. We will now mention how the Hollerith method was used to facilitate the scoring of the responses of an individual pupil.

The 8 scores coming from the 8 averages above are:

2 2 1 1 —1 2 0 0

These 8 scores are punched on a short Hollerith card as illustrated in Fig. 164. The left end of the card is used for the punchings corresponding to a second response (next alphabetically) to the same stimulus word. Thus 23 cards provide for the not-exceeding 46 response scores for each stimulus word. The 23 cards were filed in a folder, the compartments so staggered that the response words were at all times visible. In scoring the 198 responses of a given pupil, the operator would note the first response, find the card giving it, withdraw it from the staggered folder, insert (if a B-response, first turning the card end for end) into a specially constructed reading unit of the tabulating machine, and press a lever. As a result of this the 8 scores are recorded in the appropriate

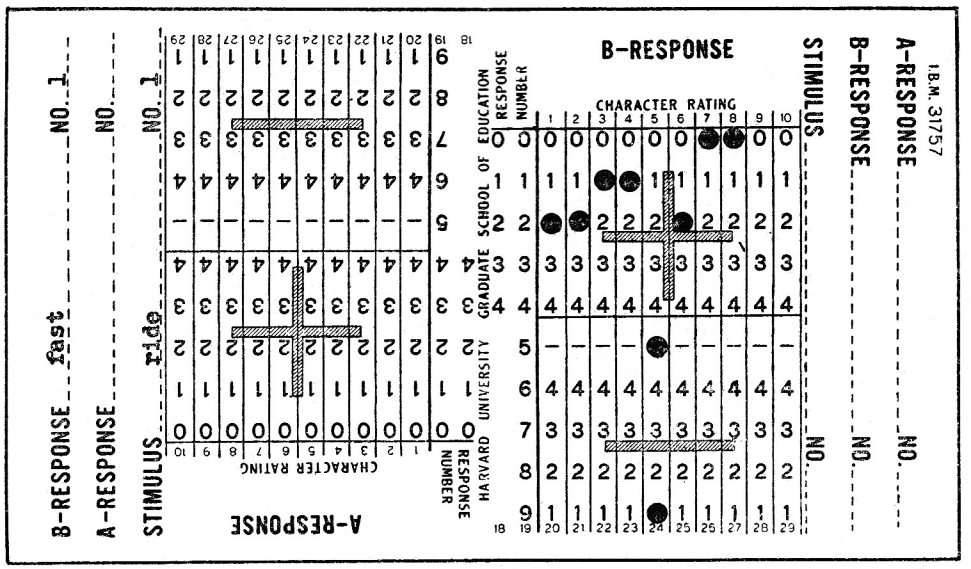

FIG. 164

columns of a tabulating printer. The card is then replaced and the folder containing the 23 cards flipped forward so that the next folder is revealed. The operator notes the response to the second stimulus word and proceeds as before. Having run through the 198 responses, 8 printed totals result, giving the subject's 8 character trait scores.

This method of scoring was about 2½ times as rapid as manual scoring, and undoubtedly more accurate, but even so the time cost, 25 minutes per pupil, is not sufficiently low to make the character test scores from this free association test as inexpensive as are most achievement test scores.

PART VI

Applications in Medical Research and in Hospitals

PART VI

Applications in Medical Research and in Hospitals

CHAPTER I

Hospital and Clinical Statistics in General

By
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THE adaptation of modern tabulating machinery to the needs of hospital and clinical statistics and the use of statistical technique in the analysis of such data are as yet comparatively new and untested methods for the hospital administrator and the clinician. Many experiments have been attempted in the last decade to adapt tabulating machinery to the needs of medicine. Without doubt, mechanical tabulation will play a highly important role in the future advance in clinical research as well as in hospital administration since it introduces a powerful coordinating element into modern medicine which will strengthen and tend to draw together all of its integral branches.

The average physician or medical investigator views the subject of hospital and medical statistics as a highly specialized field of medicine. Even those who work in the field usually approach it from a somewhat narrow viewpoint—such as tabulation problems or technical statistical analyses. It is the intent of this chapter to give a panorama of the entire field of statistics as applied to medicine and hospitals, to delineate the major divisions of the subject in an attempt to define the range and boundaries of this field as well as to describe specific applications of Hollerith tabulating machinery.

Whether the facts gathered in hospital records are reliable or not, it is obvious that an enormous amount of such information is gathered by any large hospital and that this wealth of accumulated knowledge is more or less sterile at the present time due to the lack of a systematic record plan. A large portion of the present knowledge of disease has come from the bedside notes of the physician. Even before the comparatively recent development of laboratory procedures in medicine, the clinical record furnished the cornerstone for the advance in medical knowledge. With the coming of modern scientific medicine, the necessity of recording an increasing number of quantitative facts has made adequate record notation indispensable.

Hospital and medical statistics may be defined as the process of collection, tabulation and analysis of the sum total of administrative and clinical facts gathered upon the patients in the hospital. The goal toward which hospital

statistics should be directed is the integration of all these various types of facts in order to make possible better administration, to advance the knowledge of medicine and to bring about better care for the patient.

The Responsibility for the Collection of Hospital Statistics and the Reliability of Facts Collected

There is an administrative, nursing and clinical responsibility involved in producing an efficient system of hospital records. In general the various types of statistics to be gathered fall into five broad categories—clinical diagnoses and findings, factors concerning census of the patient population in the hospital, records of services rendered by various hospital departments, knowledge concerning hospital personnel, and data of various financial elements which are essential for hospital administration. In connection with all of these various types of statistics which are gathered, the reliability of the facts themselves comes under constant question since the analyses and conclusions drawn from the statistics can never be better than the original data which are gathered. This is true of both administrative and clinical statistics. When clerical help is used, one must be constantly on guard for discrimination by the patient against the questions of a lay person. Even in such questions as age, financial status of the patient, or occupation, it will be found that a clerk frequently has difficulty in eliciting the same type of information that the doctor receives upon careful questioning. No one has systematically studied the differences among answers obtained from the patient by the doctor, intern, nurse, or resident taken independently on the same patient. Numerous experiments along this line which have been tried by the author disclose disturbing discrepancies. Since the responsibility for obtaining facts must be shared by the administrative, nursing and medical staff, it is found advisable to place as much of the burden on the administrative clerical force involved with the admittance, discharge and record room as possible, and place the burden of all other items, except those which can be done only by the staff, upon nursing. This involves the clinical staff with the minimum amount of notation and frees the doctor's time for care of patients. However, there are certain data in the clinical record for the gathering of which it is necessary for the physician in charge of the case to accept the responsibility. These involve as a minimum, a statement by the physician in charge upon entrance of the patient, a check up of the findings of the intern, notation of staff progress notes throughout the stay of the patient in the hospital, and a discharge statement of instructions to the patient together with final diagnoses. It is not possible for the nurse, intern, or clerk to take over these functions from the clinical staff except in as much as they might write down what is directly dictated.

Dr. Caroline R. Martin, in the Central Medical Statistical Bureau of the Department of Hospitals in the City of New York,* feels that considerable advance can be made if a well-trained, high type of record historian is introduced into the scheme of record taking. She pays particular attention to training an applicant for such a position, requiring as a pre-requisite the training

* "Hospital Medical Statistics." By Caroline R. Martin—Lippincott & Co. 1933. 1-89.

of a graduate nurse, a college degree or its equivalent, and a demonstration of executive ability in previous work. With such personnel she seeks to develop a type of record historian with sufficient knowledge and background to intelligently interpret records and determine their completeness. Undoubtedly, such trained workers help considerably to gain the cooperation of the clinical staff in completing the necessary part of the record which can only be supplied by the physician in charge of the patient. Dr. Benjamin Hoyer and Dr. A. Graeme Mitchell of the Children's Hospital, Cincinnati, Ohio (1929),* feel "that the resident staff is practically the keystone around which a good system of records for better study is built and a record for such purposes is as good as the recognized ability of its least efficient member." Dr. T. R. Ponton for years conducted a weekly meeting of his heads of departments at Hollywood Hospital, Los Angeles, at which they criticized all records of the hospital of those patients which had been discharged the preceding week. Without question, some device is necessary if the variety of interests concerned in hospital records—those of the doctor, intern, nurse, administrator, accountant, bookkeeper, record librarian, social service worker—are to have their activities correlated to a degree which will develop record consciousness in the various hospital groups.

Perhaps the most important and most neglected element which should be considered in the accuracy of facts entering the hospital record is the patient himself. Patients are extremely variable in their mental ages, sociological backgrounds and degree of illness. All of such factors should be taken into consideration if the goodness of the facts which the patient renders to the questioner is to be evaluated. In order to demonstrate how much variation there is in the *same* patient concerning answers given to the clinician, an experiment was conducted in which two staff clinicians attempted by independent efforts and combined efforts, employing both direct and indirect questioning, to elicit the true description of the type of abdominal pain felt by a certain patient suffering from peptic ulcer. After persistent trials over five or six days, the patient's story finally became consistent. Whether the consistent description finally arrived at represented the accurate description, there was no way to verify. It is certainly true, however, that if this patient had been questioned in the routine manner, the accuracy of the first description as given by the patient and placed on the record would never have been doubted.

Definition of Terms and Nomenclature

Having arrived at the conclusion that hospital statistics can be no better than the facts from which they are derived and that no amount of high-powered mathematical analysis will replace or serve to differentiate inconsistencies and inaccuracies in the original data, it is necessary to examine those elements that have to do with the definition of terms and nomenclature of diseases, surgery, and therapy which serve as the terminology for the data involved in hospital statistics.

The definition of those facts gathered for administrative purposes offers

* "Records and the Record System of the Children's Hospital, Cincinnati, Ohio." By Benjamin Hoyer and A. Graeme Mitchell—Methods and Problems of Medical Education, Rockefeller Foundation, 14th Series, 1929. Pp. 151-207.

less difficulty than those involved with nomenclature of disease and surgery. However, even in this rather clear-cut administrative field, there are many factors which should be definitely defined and which at present are not so defined. For instance, the most common unit to compare cost information between hospitals is the so-called per-diem cost. In a study conducted by the various University Hospitals in the middle west region, variations in the per-diem cost between the several University Hospitals were discovered to be very largely due to differences in definition of the elements incorporated in the per-diem cost figures. One institution, for example, did not include heating because the steam was metered and supplied by the University without charge. Another institution found that a considerable element of its per-diem cost was involved with carrying certain expenses in connection with bonded indebtedness which did not exist in the other institutions. In some instances, school charges for teaching were levied against the school, in others against the hospital. The conclusion is unavoidable, that even in institutions of practically the same type and character, per-diem costs can not be compared unless clear-cut definitions exist as to exactly what elements should go into these costs.

From the clinical standpoint, definition of terminology and an appreciation of the function of nomenclature of disease is essential for indexing or tabulation of clinical statistics. A tremendous amount of effort has been expended over the course of the last hundred years to bring about consistency in medical nomenclature. The last major effort of this type in this country resulted in the production of a Standard Classified Nomenclature of Disease compiled by the National Conference on the Nomenclature of Disease.

Since the whole problem of medical nosology is the basis of the clinical side of hospital statistics, it is necessary to appreciate the various elements and problems involved in this subject. Clinical nosology consists of four major divisions; first, definition of disease entities; second, nomenclature of diseases or the assignment of appropriate names which are acceptable to those that use them; third, classification of terminology in some methodical or convenient order; and fourth, adaptation of an appropriate coding system of nomenclature and classification of disease which will best serve the statistical function of cross-index and the tabulation of data collected in the clinical record.

The definition of disease entities and of surgical and therapeutic procedures is the first function of medical nosology. At present the dictionary offers the only means to meet this need. In a subject advancing and changing with the rapidity of medicine and surgery, it is difficult to keep definitions abreast of new usage and significance. Lexicography is not a science which plans new words for the future; it is merely a record of the past and a device to be used to bring about a certain amount of standardization in speech. Not only is clinical terminology constantly expanding in the use of new terms but old words take on new senses, while others descend into disuse. The medical scientist is continually forced to extend accepted terminology in order to express new concepts and meanings. At best, definitions of terms in a progressive science like medicine must always be provisional. At present the only useful clinical method of defining diseases seems to be by the distinction of particular diseases in terms

of the occurrence of more or less constant combinations of symptoms and physical findings presenting themselves in succession over a period of time. This method serves to list the leading characteristics of one disease which distinguishes it from every other. Objections are leveled against definitions of this type on the ground that disease entities are variable in character. Such objections have been overcome in many instances as the advance in knowledge of scientific medicine brings to light more specific characteristics. Consequently, the definition of disease serves not only a nosological function but also renders the diagnoses themselves more perfect. Pathologists in particular frequently object to the employment of symptomatology in definition of medical terminology believing that such definitions should be derived from the internal pathological condition underlying the external phenomena of the disease especially for those conditions involving lesions found at autopsy. Definition of disease entities by their causes is advocated by others and yet this method also leads to error in as much as causes are disputable and even when known are frequently co-dependent on numerous contributory causes. Whatever principle is used in the definition of disease, it is essential that the definition be independent of theory and tied to factual findings. We must probably be content with methods of definition which best serve the practical purpose of correlating the average picture of the disease to the accepted modes of expression and be willing to permit a considerable amount of collateral description to be included when the definition can not be made sufficiently complete by a single concise phrase.

The selection of the best name for a given disease entity is the function usually ascribed to medical nomenclature. Differences of opinion exist as to the proper basis for selection of the best name. The following methods have been used at one time or another. The name of the author first describing the condition, e.g., Raynaud's, Recklinghausen's; the most characteristic symptom of the disease entity, e.g., melancholia, spasmophilia; the name taken from the part affected together with the most characteristic symptom, e.g., angina pectoris, otalgia; a description of the morbid appearance or change in the tissue, e.g., hepatitis, appendicitis; a direct relationship to the causative agent, e.g., lead poisoning, sunstroke, tuberculosis; analogy of the condition to external objects, e.g., elephantiasis, polypus, etc. With advance in medical knowledge many terms which have been regarded as disease entities have proven to be either a combination of several conditions or a symptom of numerous conditions. This means that no clear-cut boundary line can be drawn between the name of a disease and a symptom, the one merging into the other.

In view of the confusion existing in nomenclature and the passion for invention of new terminology, it would seem advisable to effect if possible a systematic clearance of new names through some recognized and approved central agency such as the National Committee on Medical Nomenclature which could serve the purpose of correlating the new name as an appropriate approved or non-approved subdivision of some established and recognized category for the tabulation of disease. This precaution would at least prevent confusion by establishing the position of a new term among those which have been accepted by the collective mind of the medical profession.

Classification of disease has been and continues to be a battle ground for the conflicting interests and desires of various medical groups. The Standard Classified Nomenclature of Disease recommends a dual classification—first an anatomical depending on the site of the disease and second, an etiological. The anatomical begins with the body as a whole and proceeds through the different anatomical systems while the etiological is subdivided into those diseases the cause for which is clearly known, those which can be attributed to a secondary cause and those whose cause is entirely unknown. Each disease entity is made up, therefore, of two component parts, the site and the etiological factor, because every disease is considered to be the result of a cause acting in some organ or tissue.

While this seems simple enough as a general outline, it does not seem possible to distinguish all clinical entities clearly on this basis alone. For instance, chronic osteomyelitis and acute osteomyelitis are distinguished not by etiology or anatomy, but by the duration of the pathological process; pulmonary tuberculosis, multiple tuberculous abscesses of the lung, and tuberculous pneumonia are three distinct entities that have etiology and anatomy in common.

There have been a great many classifications of disease entities used by the medical profession in the course of the last hundred years. Each has arisen from the desire to arrange the nomenclature in the most natural order possible for convenience and facility of usage. However, there does not seem to be any one most natural order for all purposes because the aims of the various groups themselves are at variance. It is true that for any special purpose it is possible to arrange terminology to a best advantage and it is the legitimate right of the person or group interested in such a purpose to re-arrange or re-classify in a way which will best serve the object in view. Classification is only a method of generalization and logically there should be as many "best" classifications as there are purposes to be served by such. Consider the different viewpoints of those concerned in the use of a medical nomenclature: the physician, the surgeon, the pathologist, the therapeutist, the anatomist, the embryologist, the bacteriologist, the physiological chemist, the physiologist, the medical jurist, the army or naval officer, the hospital administrator, the medical statistician, etc. The reason for selection of some one classification depends upon the fact that men differ in their estimation of the value of various classifications because their purposes vary and because the consideration of the facts is not regarded from the same point of view. Any one plan must of necessity be artificial since it is arranged to elucidate or support a given theory or to attain a definite end and consequently the most that can be hoped to be achieved is a limited interpretation of a particular viewpoint.

Since there can as yet be no one classification which leads to a natural classification based on the mutual interrelationship of disease entities and which will agree with all facts known or unknown as they exist in nature, it is unwise to attempt to fix too rigidly any one classification. The classification accepted for general usage should not be linked to the method of cross-indexing in such a way that it denies the physician the right to obtain those records in which he might be interested, regardless of his viewpoint or his purpose. Every plan

or suggested rearrangement of disease by any medical investigator should be accepted for what it is worth and evaluated according to the manner in which it fulfills the object for which it is devised.

The progress of medicine will be advanced by establishing useful, broad classifications if the classification scheme itself is not allowed to throttle new attempts at reclassification and study. The tool by which classification can be retained and at the same time not be allowed to throttle the flexibility or the availability of the records in the hospital cross-index, will be found in the invention of a flexible coding system, the numbers of which will be linked to the definitions of the terminology rather than to the unit of classification of such terminology.

A satisfactory coding system should fulfill the following functions: it should permit of no variation in judgment as to how the clerk may assign a code number to a given medical term; it should eliminate differences in coding of a degree of fineness, the differentiation of which would lead to a conflict of opinion between physicians; it should be grouped into major and minor numbers, the major numbers consisting of broad categories suitable for tabulation and comparison of morbidity statistics, the minor suitable for further differentiation of these broad categories; it should be adapted to the use of punched card and mechanical tabulation; and finally, it should permit almost unlimited expansion for new terms without the destruction or replacement of code numbers already existing for terms in active use.

Before any system of nomenclature can be considered to be adequate for the needs of both clinical and statistical medicine, it will be necessary to construct a cross-index guide for the use of both code and nomenclature. To be effective, such a guide will probably evolve along the general lines adopted in Roget's International Thesaurus, which by means of its index guide and its prominent key words serves to relate each word to synonyms, to closely related words or phrases, as well as to antonyms. Only with the completion of such a mechanism will all the records on any given clinical subject be made available to the physician or medical investigator.

Record Forms and Methods of Collection of Data

Record forms are essential for the collection of data which are to be used for purposes of administrative control, analysis, or medical research. Suggestions for record forms and standardized accounting technique in hospitals have been made and advocated for the past twelve years by a sub-committee of the American Hospital Association. The report of the council's Division on Hospital Accounting of the American Hospital Association convention of September, 1933, summarizes the unsatisfactory condition existing at present in the administrative and financial records of hospitals.

"The purpose of the Division on Accounting is, of course, to reconsider the question of hospital statistics and accounting, for although much excellent work has been done by various committees in the past, it is felt that there still remains much confusion in the hospital world in the matter of comparative costs, distribution of expense, unit costs of services, etc. Unfortunately, the

recommendations of the former official committees on accounting were not followed up by representatives of the American Hospital Association and such recommendations did not receive general adoption in the field. The growth and increased complexity of hospital services in the past decade is another factor which has led to an increased need for a study and revision of principles and practices of hospital accounting and a further attempt at uniformity and standardization. Indeed it is doubtful if any business comparable in size and importance to the hospitals of this country would tolerate such a chaos of accounting peculiarities as exist today in our institutions. Individualism has run rampant and the smug complacency of administrators, combined with the apathetic attitude of boards of trustees, has made almost impossible the intelligent appraisal of a hospital balance sheet and statement of financial operations.

"During the past few years, however, the public and the organizations which represent the public have become more critical of the vagaries of hospital finance and they have also become more articulate in their demands for more definite details of income and expense in the institutions which serve them. They are not content to believe that charity should cover a multitude of accounting sins and are more and more insistent that a hospital, while not a business, must at least be run in a business-like manner. . . .

"In dealing with the subject of periodic financial reports, it is believed that these should include:

(a) Balance sheet
(b) Statement of income and expense
(c) Unit costs and unit incomes for each of the important professional services.

They are inclined to the view that the financial records should maintain income and expense accounts, insofar as possible, on the accrual basis rather than on the basis of cash receipts and disbursements.

"In the suggested principles or criteria of an acceptable system of statistics and accounting for hospitals, the opinion is advanced that a uniform classification of accounts should:

(a) Be simple. The accounts should be relatively few in number and of such nature that they apply to hospitals generally, regardless of size, location, special function, or policy.
(b) Be elastic. The basic uniform accounts should be selected with a view to sub-classification by hospitals requiring more detailed information.
(c) Be based upon hospital organization—that is, the administrative units of the hospital, with sub-classifications for the types of commodity or service.
(d) Be arranged to facilitate the apportionment of income and expense to the various professional services. Hospitals should adopt uniform bases for allocation of expenses and income, and uniform definitions for unit costs and income.
(e) Be accompanied by a 'budget system' which predicts and fixes administrative responsibility for financial transactions."

The collection of clinical data for purposes of cross-index analysis and research also depends to a great degree upon the use of record forms adapted to the needs of tabulation of statistical analysis. The Committee of the American Hospital Association on clinical records after four years of study submitted at the September meeting of the Association in 1933 a specific list of recommendations as to the type of record forms which should be used in two fields, namely the general history of the patient and a system of records to be used in the Out-Patient Department. In all, they recommended and demonstrated 35 record forms in their report. The titles of these record forms are as follows: Statistics card, Admission Order, Graphic Chart—4 hour, Graphic Chart—blank, Nurses' Record of Treatment and Systems, Doctor's Orders, Orders for Treatment, Minor History, Report of Minor Operation, History, Physical Examination, Progress Notes, Consultation Record, Radiological Consultation, Laboratory Report Sheet, Report of Operation, Report of Anesthesia—2 sides, Accident Report, Autopsy Report, Permit to Operate and Give Anesthesia, Release from Responsibility for Discharge, Release from Responsibility for Abortion, Autopsy Permit, Social Service Report, Summary of History—OPD, Identification Card, Appointment List, Appointment Card, Requisition for Medical Record, Index of New Patients Admitted to Services, Index of Nationality of Patients, Index of Residence of Patients, Index of Age and Sex of Patients Admitted, Monthly Summary of Visits to Services, Disease Index, Monthly Report of the Out-Patient Department.

Principles Involved in Collection and Use of Medical Records

All medical records can be divided into two general types, the clinical record and the medical data sheet. Any other type represents a compromise between the two extremes. The clinical record is defined as a sequential statement of the important facts about a patient's condition and physical findings while a medical data sheet is defined as a record form adapted for the notation of the patient's history and physical findings suitable for statistical tabulation and analysis. The clinical record must fit the needs of the busy doctor in his relationship with his patient while the medical data sheet must fulfill the qualifications of a scientific record with respect to completeness, accuracy, and ease in notation and tabulation of facts. It is true that statistical tabulations can be made from both the clinical record and the data sheet, although lack of completeness in notation of facts and expense involved in the extraction of data from the clinical record makes this type of record unsatisfactory for most statistical purposes. The primary consideration in good history-taking, from the standpoint of the physician, is to obtain the *essential facts* at the expense of the non-essential. Dr. Raymond Pearl (1921)* expresses the dissatisfaction which the statistician feels toward the clinical record. "From the standpoint of scientific routine record-taking, case histories are most glaringly defective in what they fail to record about the patient. It is by no means impossible to find case histories that fail to record the sex of the patient, while any indication of what kind of person

* "Modern Methods in Handling Hospital Statistics," Raymond Pearl. Johns Hopkins Hospital Bulletin, Vol. XXXII, No. 364. June 1921. 183-194.

the patient was, in the common sense of the word, whether fat or lean, white or colored, rich or poor, young or old, etc., is all to frequently kept a deep secret from any subsequent reader of the history. Again, even in the special medical portions of the history the writer forgets, with almost unbelievable frequency, to make any record of highly important facts.

"The root of such difficulty apparently lies in the method by which case histories are written. The general scheme or outline which a history is to follow resides, far too often, in the head of the history writer, and there only. And heads, especially of human beings, do vary so! The remedy is patent. Any hospital or service that desires to put its clinical records on the most scientific basis will, as a first step draw up and have printed a series of standard history forms, which will cover not merely general routine facts common to all diseased conditions, but special forms as well, for at least all of the more frequently occurring conditions. These blank forms will contain definitely indicated spaces in which some statement of fact absolutely must be recorded in every single case."

Perhaps a tabulation of the principal similarities and dissimilarities between the clinical record and the medical data sheet will serve to make clear the difficulties involved in any attempt to fuse these two types of records or to use data extracted from the clinical record for statistical tabulations. (See table on opposite page.)

This tabulation of essential differences and similarities between the purely clinical record and the medical data sheet brings out the fact that the important requirement from the standpoint of the clinician is to obtain continuity in the record, which, when taken in conjunction with the necessity for expansibility and adaptability of the record to the multitudinous conditions and findings in the patient, necessitates elimination of the collection of non-essential information in the record.

Certain sheets in the patient's record are essentially data sheets, others are clinical records and still others are a fusion of the two types of records. Almost every type of institution has some sort of a sheet for registration and discharge data which can be considered to be a data sheet as it has been defined above. Admission and discharge information together with provisional and final diagnosis and condition on discharge are usually assembled on this sheet. This is a logical combination, since these facts are the sum total of what is desired for indexing by most hospitals, and since it facilitates indexing by bringing together in one place all elements to be indexed. Other records used as data sheets, are the clinical laboratory, temperature, and special study forms. The sheets which are usually in the form of the clinical record are the general history and physical examination, progress notes, nurses' notes, and X-ray reports. The group of records which are midway between the clinical record and data sheet are those used by special departments, such as pathological reports, surgical and anesthesia records, etc.

There is no reason why any purely clinical record can not be made into a data sheet when it is desirable to study certain kinds of disease conditions. For instance, a great deal of effort has been expended by the Association for the

Needs to be filled by the Record	*Clinical Record*	*Medical Data Sheet*
1. Continuity	Continuity is a prime essential. It is largely obtained by rough ordering and the elimination of non-essential information.	Continuity is obtained solely through order and fixation of places for given facts in the record.
2. Order and Sequence	Only rough order is necessary in the clinical record except for a few basic facts about the patient which demand fixation of places on the record. Arrangement of sheets in the patient's record helps sequence.	Order, arrangement and sequence are essential. They are obtained by fixation of places on the record for given facts and the arrangement of sheets in the patient's record.
3. Conservation of notation time.	It is absolutely essential to conserve the time of the doctor. This end is gained first by shifting all possible record work upon clerks or nurses, and secondly, by omitting the recording of all non-essential medical data.	It is desirable to conserve time but if it is not possible to do so except at the sacrifice of completeness, in the notation of facts, conservation of time becomes a matter of cost.
4. Condensation in presentation of facts recorded.	A condensed and itemized form is desirable.	A condensed and itemized form is desirable.
5. Ready yield of information	While this is desirable for essential information, it is not necessary for information which is of minor importance in the patient's condition.	This is essential for all facts on the record, no matter how minor.
6. Accuracy	Accuracy is desirable but is rarely checked.	Accuracy is desirable but is frequently not checked except for completeness and for apparent errors.
7. Legibility	Legibility is essential.	Legibility is essential.
8. Expansibility and adaptability	The ability to expand and adapt a record is very essential to the physician.	The ability to expand and adapt records is desirable but can be obtained only with difficulty since it is impossible to prepare a blank form which can completely satisfy every need for the whole history and physical examination.
9. Completeness of notation	A reasonably complete summary note of the more important items in records usually suffices. This can be done by the staff after discharge of the patient.	Completeness of notation is essential in all details which are desired for tabulation. This can be accomplished only by close clerical check before the patient has departed from the doctor's care.

BASIC REQUIREMENTS OF CLINICAL RECORD AND OF MEDICAL DATA SHEET

Prevention and Relief of Heart Disease (1922) in establishing and attempting to popularize an elaborate data sheet for cardiac conditions. Even though this association was backed by considerable medical opinion, it did not completely succeed in obtaining the adoption of its record. Certain data sheets backed by the American College of Surgeons and the American Medical Association, in particular their forms for recording fractures and for periodic health examination, have enjoyed a moderate success.

Dunn and Rockwood (1928)* made an effort to throw the more important facts in the general history and physical examination into a data sheet. In spite of the ease of notation of negative facts, their record obtained no popularity due to the feeling that much of the negative information gathered was non-essential. A study of 584 of these records which were taken on patients at the Maryland University Hospital from November, 1927, to September, 1928, showed conclusive evidence of considerable improvement in the determination of the actual facts obtained. In the evaluation as shown in the accompanying table, a history record was called good if it was complete except for errors in not more than two or three sections of the record, and poor if it contained many mistakes and omissions resulting in an accumulation of data of about the same order of completeness as that obtained in the average clinical record.

November 1927—September 1928

Department	*Good* No.	*%*	*Fair* No.	*%*	*Poor* No.	*%*	*Total*
Taken in Department of Medicine	81	*29*	98	*35*	99	*36*	278
Taken by other Departments	17	*6*	112	*36*	177	*58*	306
Total	98	*17*	210	*36*	276	*47*	584

November-December 1927

Department	*Good* No.	*%*	*Fair* No.	*%*	*Poor* No.	*%*	*Total*
Taken in Department of Medicine	42	*68*	16	*26*	4	*6*	62
Taken by other Departments	9	*20*	28	*64*	7	*16*	44
Total	51	*48*	44	*42*	11	*10*	106

During the experiment there was supervision over the records by one of the staff in the Department of Medicine for the time period of November and December, 1927, while in the other departments there was no supervision at any time. It is interesting to observe that completeness of notation in a form record of this type could be obtained only two-thirds of the time even with close supervision of an interested staff member. As a consequence of this experiment, the conclusion was reached that it is futile to attempt to better the clinical record by introducing a record form unless the staff members are willing to supervise the record taking in order to obtain data suitable for tabulation and research.

It is an open question whether students should be trained by letting them fill out forms as a substitute for a clinical history. It is certainly true that the art of where to expand a history and how to question the patient in order to get at essential facts about the patients history, and the ability of the questioner to expand and frame his questions so that they produce correct and fruitful answers, will not be obtained by the use of blanks. At the same time, it is probable that a certain amount of fixed order obtained by printed forms would result in somewhat better records and in developing an orderly, systematic approach to the patient by the student.

* "A Record System Suitable for Both Clinical and Statistical Medicine." Halbert L. Dunn and Reed Rockwood, Arch. Int. Med., Apr. 1928. Vol. 41. Pp. 499-535.

It is to be hoped that some compromise between the data sheet and clinical record can eventually be adopted rather widely throughout the country, at least with respect to the routine history and physical examination. If this were possible, corresponding records in the various special departments could be developed which would dovetail with the general history and physical examination sheet. It is not to be expected that data sheets will ever replace the clinical record forms, although there will be more and more modifications of clinical records to meet partially the requirements of the data sheet. Let there be no illusion, however, that the clinical record can ever be used satisfactorily for the extraction of information for study. This process is expensive and invariably results in information totally inadequate for statistical study. In a system involving nothing but clinical records, a physician who wishes to study epilepsy, for instance, should construct a data sheet, collect records upon his epileptic patients, and fill out an approximately equivalent number of data sheets on non-epileptics for the sake of control. He should carry on such a study until he has sufficient data for the statistical analysis which he desires to conduct.

It would be highly desirable for any physician to have at his command a considerable variety of data sheets—at least one for each specialty of medicine, so that when he happened on an unusual or rare case he could systematically go through and fill out all such data sheets and present to the current medical literature case reports which would be truly complete and capable of statistical treatment. If a sufficient number of such reports were published to make it possible to study the rare disease from the quantitative standpoint, definite progress would be made in medical knowledge.

Routine Tabulation of Hospital Statistics

It has been previously stated that the type of statistics usually gathered by hospitals for the purposes of tabulation fall into five broad categories: the clinical diagnoses, findings, and therapeutic procedures, census facts, services rendered by various hospital departments, routine records of personnel and financial data.

The administration of the hospital usually necessitates daily, weekly, monthly, or yearly reports of some type. No uniformity exists at present in the character of these reports. A survey of many such reports indicates the desirability of standardization and simplification of this entire subject. In order to obtain standardization and simplification simultaneously, it will be necessary to recognize the general principles of tabulation involved, namely, that all facts to be tabulated must be divided into three classifications: first, those facts which are of sufficient importance to justify daily, weekly, monthly or yearly tabulations and which should be studied each time they are collected in order to determine any change in their trend so as to insure the hospital administration that maladjustments have not occurred within the institution; second, those which should not be tabulated routinely but which should be readily available at all times in order that any significant difference in the trends of the facts tabulated routinely may be further analyzed to explain the meaning of such deviations; and third, those findings which should only be collected and made available for tabulation

in connection with special studies and which do not need to be routinely available at all times.

It is obvious that if the facts in the first group can be limited to a very few in number, the complex picture which is likely to face the hospital administrator can be simplified considerably, and yet when necessity arises, he will not be handicapped in obtaining an explanation of changes in trends of these critical facts if he has data available in detail for a more elaborate study to supplement his comparatively simple routine tabulations. Since no routine monthly or yearly reports have been accepted and approved by the hospital organizations, it is not possible in this article to submit the exact record forms for tabulation which should be made monthly or yearly by hospitals. It is perhaps possible to point out the general type of facts which should be incorporated in the monthly and yearly reports.

Although a large number of hospitals make some attempt at routine tabulation of clinical facts in the monthly and yearly report, there is considerable doubt whether this is desirable. The criteria by which judgment should be made is whether such a tabulation of diseases and surgical operative statistics will find actual use by either the physician or the administrator of the hospital. It is certain that the staff of the hospital will find it essential to have available at any time an adequate cross-index in order to obtain the case records of diagnoses or operations. Any complete tabulation of the diagnoses and operations of any institution has little meaning outside of the institution itself unless there is knowledge available concerning the character of the patient population which comes into the hospital. The accuracy of a generalization of hospital morbidity or mortality statistics with reference to the morbidity of the community as a whole depends entirely upon a knowledge of the type of patient population which is admitted to the hospital and how it has been selected from the community. Practically every hospital varies in respect to the character of the cases which come to it and in very few instances would the character of the patient population coming to the hospital coincide with the character of the population of the community. In spite of this obstacle, there would probably be a real value for hospital morbidity statistics if they could be gathered in all hospitals of the state. State-wide hospital statistics would eliminate the differences existing between the morbidity records of any certain hospital and would, therefore, constitute an index of those cases in the community which were sufficiently serious to demand hospitalization. Until it is possible to obtain generalized reports from all hospitals in the state, hospital morbidity statistics will probably have little meaning from the standpoint of general community morbidity statistics.

There are at least two possible exceptions with reference to the statement that it is not desirable to routinely tabulate clinical facts in a monthly or yearly hospital report. The first exception involves those cases which have died in the hospital. Many institutions consider it important to submit an itemized monthly report covering all deaths within the hospital. This report interests the physicians of the staff and should be available for weekly or monthly hospital staff meeting. In many instances the staff will desire to go into each case in consid-

erable detail in order to benefit by self-criticism. The facts to be gathered in connection with hospital deaths for record purposes are few in number, viz., name, case, number, age, sex, admission date, date of death, service on which death occurred, staff doctor in charge, the fact of whether or not autopsy was carried out, the name of the operation if surgery was done, and the cause of death, together with associated conditions.

Physicians of the staff who are interested in tracing the reason for a specific hospital death will also usually desire considerably greater detail and a check of autopsy findings together with a knowledge of the clinical course of the case. The only other clinical fact which is routinely gathered by a considerable number of hospitals is a similar report concerning the unimproved cases which are dismissed from the hospital. There is some question whether such a report should be routine in character since many of these cases are brought into the hospital for diagnosis rather than therapy. Undoubtedly it is worth the effort of any hospital staff to occasionally survey all of its unimproved cases.

The second group of facts which are involved with routine monthly and yearly reports are census facts concerning the character of the patients coming to an institution. Routine tabulations of census facts could probably be limited to a comparatively few in number, such as hospital days within the hospital tabulated by department, by classification, by station, type of service together with the number of admissions, discharges, or transfers by department and classification. If there is an out-patient department in connection with the hospital, the number of new patients and re-admissions should be routinely tabulated by the department and by classification in order to serve as a measure of the activity existing in the out-patient department.

The third routine monthly and yearly report concerns certain elements of control in connection with the numbers and amount of time involved in the personnel employed by the hospital. It is probably sufficient for report purposes that the numbers of people together with the effective work hours and total pay roll be listed by department and class of personnel. It will be necessary to have available a personnel card for each individual in order to trace any change in trend of personnel factors to the individual involved.

Another important function for the routine monthly and yearly reports is to establish a measure of the load carried by various service departments of the hospital. Only the crudest measure of service load should be carried in such routine reports, the departments involved consisting of the dietary, laundry, laboratory, X-ray, operating rooms and anesthesia, dressings, dental, social service, occupational therapy, physio-therapy, chiropody, optical, pharmacy, oxygen therapy, out-calls, and other special therapy services.

The only other element in hospital statistics which necessitates routine monthly or yearly tabulations is a report of the various financial elements involved in the income and expenditures of the hospital. This report should be simple in character and consist of a tabulation of current operating income and total income, accounts receivable, cash on hand and expenditures. The current operating income should be listed by the departments which earn the income. The expenditures should be listed by budgeted departments and involve

a comparison of the budget position with the actual position of the department in any given report as well as a comparison with the previous corresponding yearly tabulation.

The above-mentioned monthly and yearly reports are the principal routine tabulations necessary for the proper functioning of the average hospital and for the determination of trends in the important administrative facts. All other data should be kept in a form which is available but not tabulated except when the necessity arises.

Although tabulations should not be made routinely upon the bulk of the facts involved, the administrator and physician should be in a position to obtain all of the types of tabulations which could be made from such facts when analysis seemed to be desirable. The picture of the type of tabulations which can be made is obtained by a consideration of the master table. To illustrate what is meant by master table tabulation, I quote the example given by Dunn (1927)* illustrating the necessity for noting negative information if scientific research is to be carried out in conection with medical statistics.

"Completeness to the clinician signifies notation of every detail pertaining to the positive facts about the case. Completeness to the statistician means positive and negative information for every single item that is of sufficient consequence to enter into the picture of the disease. It is impossible to apply the laws of probability unless the true probabilities are known.

"If negative and positive information are both known for a series of patients, a 'master tabulation' can be made from the data. For illustration, 843 patients studied by Dr. H. A. Young at the Brady Urological Institute were grouped by me into two classes, the first with moderately enlarged prostates and the second with extremely enlarged prostates. In each instance the history of retention and the type of onset were known.

TABLE A

	No. of Cases	Retention	No Retention	Sudden Onset	Gradual Onset
Moderately enlarged	780	(1) 50%	(3) 50%	(5) 7%	(7) 93%
Extremely enlarged	63	(2) 56%	(4) 44%	(6) 15%	(8) 85%
Total	843				

TABLE B

		Retention		No Retention		
	No. of Cases	Sudden Onset	Gradual Onset	Sudden Onset	Gradual Onset	Total
Moderately enlarged	780	(1) 5%	(3) 45%	(5) 2%	(7) 48%	100%
Extremely enlarged	63	(2) 13%	(4) 43%	(6) 2%	(8) 42%	100%
Total	843					

* "The Status of Statistical Medicine," Halbert L. Dunn. Jour. Am. Med. Assoc., Oct 8, 1927. Vol. 89, pp. 1273-4.

"Tabulation A has taken just as much space as B. However, there are certain questions which can not be answered by A that can be by B. These may be listed as follows:

Table A (Cell No. Noted)	Possible Questions	Table B (Cell No. Noted)
	Percentage of	
1	Retention, Moderate	1 and 3
2	Retention extreme	2 and 4
3	No retention, moderate	5 and 7
4	No retention, extreme	6 and 8
5	Sudden onset, moderate	1 and 5
6	Sudden onset, extreme	2 and 6
7	Gradual onset, moderate	3 and 7
8	Gradual onset, extreme	4 and 8
	Retention and sudden onset, moderate	1
	Retention and sudden onset, extreme	2
	Retention and gradual onset, moderate	3
	Retention and gradual onset, extreme	4
	No retention and sudden onset, moderate	5
	No retention and sudden onset, extreme	6
	No retention and gradual onset, moderate	7
	No retention and gradual onset, extreme	8

"Eight additional questions are evident in master Table B which have not been and can not be answered in Table A. It is obviously impossible to form Table B unless all information, both negative and positive, is known on each one of the 843 individuals."

It is evident that no very large tabulation in master table form will be found useful because of the elaborate detail which it involves. The principal use of the master table is to enable the administrator or the physician to visualize all of the possible arrangements by which data might be tabulated in a given study. If many studies are to be made on data which are available but not tabulated, it becomes necessary to proceed from hand to mechanical methods of tabulation. In no other way except by modern punched card machinery can any very large mass of data concerning complex facts be made available for tabulation. Hollerith tabulating machinery is particularly adapted to the analysis of those data which do not need to be routinely tabulated but should be readily available at all times and also those data which should be collected only in connection with special studies and do not need to be routinely available.

Specific Applications of Hollerith Tabulating Equipment to Hospitals and Clinical Medicine

A number of hospitals and clinics have made adaptations of Hollerith tabulating equipment to practical administrative and clinical hospital problems. Among the largest of these developments is that of hospital medical statistics in the Department of Hospitals of the City of New York by Dr. Caroline R. Martin, described in her book on the subject (loc.cit.). At the Mayo Clinic all statistical work both for cross-index, analytical research tabulation and some of the business office routine is accomplished by punched card machinery. An

* "Prospectus of Minnesota Hospital Statistical Bureau." Halbert L. Dunn, Jr. Lancet Vol. LIV. No. 6, New Ser. March 15, 1934 pp. 148-156.

attempt along this line is being made by the Minnesota Hospital Statistical Bureau in the process of formation, described in Journal Lancet, March 1934.*

There are at least two score of large hospitals at the present time who are either experimenting or considering the feasibility of installing tabulating equipment. Among these are numbered several of the University hospitals and state maintained institutions.

There are several principles to be observed in the adaptation of a punched card to a specific subject. First, it is well to establish some indication on the card as to the identity of the card itself so that it will not become confused with cards adapted to other studies which are carried in the same card file. Second, it is desirable to place the entire study on one punch card whenever possible because the process of sorting and correlation is easier if this can be effected. Third, it is desirable to make no more than one punch in a card column if the card has sufficient capacity to accommodate the study since it is not practical to print information which has more than one punched hole per column. Fourth, all data contained on the card should be available for purposes of printing if any likelihood exists that it will be used for tabulation. Fifth, if the capacity of the card is not sufficient to carry all of the variables involved in a given study, multiple punching within the column may be resorted to in order to add to the capacity of the card. One example of multiple punching is given in the geometric code published by Halbert L. Dunn in the Journal of the American Statistical Association, September 1932. Dr. Toops describes the method of adapting this code (page 202 of this book) so that as many as 240 different variables may be punched into one eighty column Hollerith card. Sixth, when it is impossible to obtain sufficient capacity on one card to carry complete information and it is not desirable to use the device of multiple punching because printing is necessary, it is advisable to have secondary cards which parallel the primary card. When it is necessary to employ the device of secondary cards, it is highly important that all factors, which represent elements of sufficient importance to be considered major tabulation categories, should be carried throughout both the primary and secondary cards in the same column location on the card and that these factors be coded by multiple punching so as to take up as little column space as possible. Seventh, it is always necessary to build with great care the codes which are to be used for translation of the material on the records to the punched holes in the cards so that the task of coding and punching will involve a minimum of clerical time.

At present the Hollerith equipment has been adapted in several localities to one or more of the following functions: (a) routine medical, surgical, therapeutic or pathological cross-indexing and tabulations of morbidity statistics; (b) correlation of statistics between hospitals either for morbidity studies or administrative cost control; (c) cost analysis and inventory; (d) collection and accounts receivable; and (e) special studies.

Routine Medical Cross Index

Several different adaptations of Hollerith equipment to the problem of case record cross indexing have been made. The following plan attempts to assemble

good points from several schemes of indexing. The data for medical and surgical cross-index are taken from the patient's record after discharge of the patient. A card is punched for each patient discharged from the hospital or out-patient department.

The following data are *essential* for such a cross-index:

(1) Case number. This is an identity number for the patient which stays the same no matter how many times the patient is readmitted.
(2) Admittance number. This number indicates the number of times the patient has been admitted to the hospital. All primary admissions are numbered one, secondary, two, etc.
(3) Geographical location of patient's home.
(4) Type of care given to patient—in-patient, out-patient, convalescent, etc.
(5) Sex.
(6) Age.
(7) Classification of patient. The code for classification of patient usually involves a division of all admissions into at least five categories: pay, part pay, free-charity, free-courtesy, and free-staff.
(8) Admission date.
(9) Discharge date.
(10) Condition on discharge.
(11) Diagnoses—Space should be reserved for at least 6 diagnoses on the same patient. Each diagnosis should be identified as to whether it is the first time the diagnosis has been made on the patient either in the current year or in the history of the patient's record of previous visits to the hospital. Also the diagnosis should be qualified as to whether it is made clinically, surgically or pathologically.
(12) Operations. Space should be reserved for at least three operations on the same patient.
(13) Section in the hospital or out-patient department.
(14) Filing number. A filing number is necessary in order to identify the punched card in case there are a number of secondary cards.

The following additional data are *sometimes* desired for routine cross-index or tabulation:

(1) Number of dependents.
(2) Number of children.
(3) Family number if the institution is correlated administratively with other city charities.
(4) Punching of name alphabetically so that it will print when the punched card is passed through the tabulator.
(5) Punching of address so that it will print when the punched card is passed through the tabulator.
(6) Names of physicians or surgeons in contact with or in charge of the patient.

(7) Information concerning special service rendered to patient such as number of laboratory tests of various types, number of x-rays of various types, number of consultations, etc.

(8) Information concerning charges made to patient, viz., final charge and itemized amounts which make it up.

(9) If it is desirable to link the statistics of the hospital to local welfare and relief statistics, space must be made for a number which will identify the hospital, for geographical codes which will locate the hospital and the family, for a code which indicates eligibility and classification of the family and for space to indicate the number of persons in the family.

The following types of data are sometimes collected on patients with certain diagnoses:

(1) Data from follow-up studies by questionnaires.

(2) Data from record extraction studies on the details of the history, physical and laboratory findings upon the patient.

(3) Other special research studies.

It is obvious that no one punched card can be planned to carry all of these manifold kinds of data without allowing for secondary cards. If space is assigned for six multiple diagnoses on one patient, each diagnosis occupying six card columns according to the code of the Standard Classification of Nomenclature of Disease and for 3 multiple operations each involving three card columns, 45 columns on the punched card would be occupied for punching of diagnoses and operations. Consequently those data *essential* for cross indexing would take up the total capacity of an 80 column card. In order to obtain an elastic cross index system adjustable to special data which might be desired in the future, it is necessary that the essential basic information be so coded and punched that it will appear in the same columns in the secondary punched cards as it appears in the primary index card. If the essential information upon the primary cross index card is condensed by means of multiple punching within the card column, it is possible to duplicate such information on various secondary cards and thus permit matching of secondary cards by mechanical means at the sorting speed of 400 cards per minute.

The basic data considered to be essential for the cross index can be coded and condensed in the primary cards as follows:

Column

1-6 Case No. (Punched direct, only one punch per column so that the number can be printed)

7 Admission

Adm. No.	No. in Column	Adm. No.	No. in Column	Adm. No.	No. in Column	Adm. No.	No. in Column
1	1	6	6	11	y1	16	y6
2	2	7	7	12	y2	17	y7
3	3	8	8	13	y3	18	y8
4	4	9	9	14	y4	19	y9
5	5	10	y0	15	y5	20	x0
						etc.	etc.

8 County and State

y
x
0 } Counties numbered and coded by geometric code
1
2

3
4
5
6 } States numbered and coded by geometric code
7
8
9

9	Sex and admission type (code so that sex will print)
10–11	Age—punched direct (code so that age will print)
12	Classification of patient
13	Admission date, mo. and yr. (geometric code)
14	Discharge date, mo. and yr. (geometric code)
15	Condition on discharge
16–27	Six Diagnoses (by Standard Nomenclature of Disease)—2 columns each, one for etiological, numbers from 1 to 1000 condensed by geometrical code, one for anatomical numbered 1-1000, condensed by geometrical code
28–33	Three operations—2 columns each (punched geometrically)
34–35	Departments—isolated punch assigned to each dept. (24 in all)
36	Filing No. to identify card—all primary index cards to be punched (1) in this column

By the device of multiple punching, thirty-six columns of the card carry all the information usually desired in a medical cross index. If these thirty-six columns are duplicated in all secondary cards, the matching of secondary and primary cards on the same patient becomes a simple sorting machine process. With this device it is possible to have as many special secondary cards as is desired and yet at all times be able to correlate special information between various secondary cards by means of any of the essential information existing in the primary cross index card.

For example: In all diabetic patients of a certain institution, it might prove to be desirable to have not only the primary index card but also a second card involving charge information, a third card involving analysis of laboratory work, a fourth concerned with the dietary history of the patient in the institution and a fifth for follow-up information after the patient has returned to his home. If the index information on the primary card has been devised as suggested above, it is condensed so that it will occupy the first thirty-six columns in the card, and if these basic data have been duplicated in the secondary cards, then the special information on the secondary cards can be matched and brought together by sorting on those columns containing basic data which have been punched in common for all cards.

In general it is to be recognized as a principle that all information not being used to tie together primary and secondary cards should be so punched that only one number comes in each punch card column. This makes it possible to list all such data in the printing tabulator. As a matter of fact, if it is desirable to print the basic data involved in the primary index card which has been condensed by multiple punching, it may be extended for printing on the right hand side of the primary cross-index card.

After the primary cross-index card has been made, two optional methods exist by which the data on the primary cross-index cards can be made available under each diagnosis and operation.

The first method is to duplicate as many of the primary cards as there are diagnoses and surgical operations and file a duplicate card under each diagnosis or operation. For example, assume that a certain patient has been diagnosed to have diabetes, cholecystitis and appendicitis and that the surgeons operated, performing a cholecystectomy and appendectomy for these conditions. The punch operator makes five duplicates of the primary index card, one of which is filed under each of the three diagnoses and each of the two operations. All of the original primary cross-index cards should be maintained in a file ordered by case number and month of discharge so that census statistics can be readily available for tabulation. Duplication of primary index cards is a machine process and can be carried out very rapidly by the duplicating or the reproducing punch. One of the punch card columns (preferably col. 80) varies with each duplicate card and has punched in it the particular diagnosis or operation under which the duplicate card is to be filed. If this precaution is taken the duplicates can be ordered for filing by the sorting machine. This method of cross-indexing necessitates that the hospital rent a sorting machine as a part of its record equipment.

A second method of cross-indexing the information under diagnosis and operation is possible and in some ways preferable to the making of duplicate cards. This method involves holding the primary cards in a straight run file for a three to six month period, sorting them one diagnosis at a time, and then printing the entire content of all the cards involved with this particular diagnosis on a sheet. For example, all the data collected for indexing upon each patient diagnosed as cholecystitis are indicated on a single printed line upon a sheet which is labeled as cholecystitis. This method of cross-indexing is particularly adaptable to the smaller hospitals which can not afford the rental of a sorting machine or printing tabulator but do have access to the use of such equipment on a service charge basis.

Correlation of Statistics Between Hospitals

As Hollerith tabulating equipment comes into more general use among hospitals it will be possible to correlate certain kinds of statistics between hospitals.

A real need exists for inter-hospital statistics. Relief funds for medical care have become available to the medical profession in limited degrees. Group hospitalization and hospital insurance plans present complex intra-hospital statistical and tabulating problems. The state, loaded with relief work and respon-

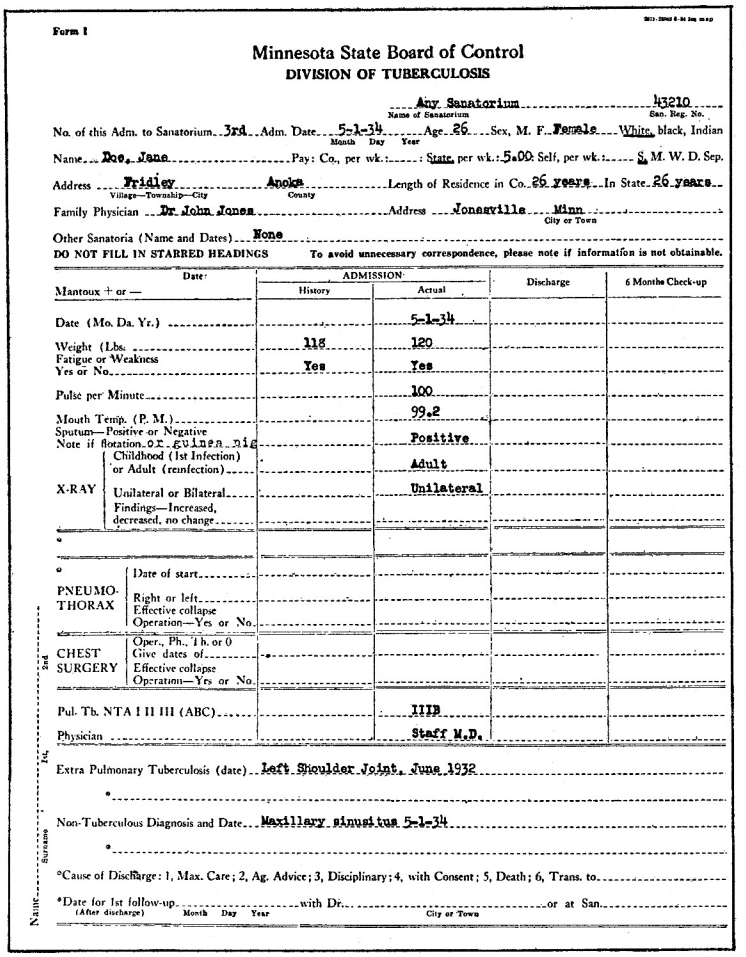
sibility for the dispensation of relief funds, has inadequate knowledge for meeting relief situations. Public charities dispensed from many organizations should have available a more complete clearance than is offered by the confidential exchanges.

Just such a plan for central clearance by means of Hollerith punch cards is being considered by the Board of Welfare of St. Paul at this time. Dr. Fred G. Carter reported the plan before the Minnesota Hospital Association at Rochester, May, 1934, under the title of "A System of Central Registry for Recipients of Charity." The plan is an inclusive one and attempts to correlate all of the various types of social service activities in St. Paul; a central file for the family history and record: an accounting punched card plan for dispensation of all material relief in the city; a punched card control for the records of medical relief and charity hospital admissions as well as for miscellaneous types of welfare activities carried on in the city. It is planned that the Hollerith cards for these various needs will be inter-linked by common codes, and will be centrally located in the City Hall of St. Paul. Such a plan will probably result in money savings to the city because it makes possible a more intelligent expenditure of relief funds.

One of the principal contributions which could be achieved if the accumulation of inter-hospital statistics were made possible by means of Hollerith equipment is the collection of generalized hospital morbidity statistics. If all hospitals of a state would report their morbidity findings to some central hospital statistical bureau in the state and if this was done in a standardized manner so that morbidity reports on those patients visiting more than one institution during the year could be corrected, a vast new source for morbidity information would be available. These data would be of particular value because they include the degenerative diseases. More complete morbidity knowledge than is available at present concerning the degenerative diseases existing in the population would be of great value in social planning for relief work, for insurance problems and for old age care. Eventually it is possible that a central tabulating bureau might be established in every state under the auspices of the state hospital or the state medical association which could act as a clearing house for problems which involve in their solution a comparison of facts between various institutions.

The following specific example illustrates this type of inter-institutional application of tabulating machinery.

There are fourteen tuberculosis sanitariums in the state of Minnesota. These sanitariums are supported in part by state funds and in part by county funds. The following plan is now being used by the State Board of Control to follow up the clinical status of the sanitarium patient. As soon as the patient has been admitted and examined the physician at the sanitarium fills out the patient's registration sheet illustrated in Fig. 165. This sheet is then mailed to the office of the Division of Tuberculosis of the State Board of Control, where a clerk types on the top of a blank 80-column Hollerith card the name of the patient, name of the sanitarium, the patient's case number in the sanitarium, the patient's home address, the admission date and the name and address of the



Form 1

Minnesota State Board of Control
DIVISION OF TUBERCULOSIS

Any Sanatorium (Name of Sanatorium) 43210 (San. Reg. No.)

No. of this Adm. to Sanatorium 3rd Adm. Date 5-1-34 (Month Day Year) Age 26 Sex, M. F. Female White, black, Indian

Name Doe, Jane Pay: Co., per wk.: ; State, per wk.: 5.00 Self, per wk.: S. M. W. D. Sep.

Address Fridley (Village—Township—City) Anoka (County) Length of Residence in Co. 26 years In State 26 years

Family Physician Dr John Jones Address Jonesville (City or Town) Minn

Other Sanatoria (Name and Dates) None

DO NOT FILL IN STARRED HEADINGS To avoid unnecessary correspondence, please note if information is not obtainable.

Date: Mantoux + or —	ADMISSION: History	ADMISSION: Actual	Discharge	6 Months Check-up
Date (Mo. Da. Yr.)		5-1-34		
Weight (Lbs.	118	120		
Fatigue or Weakness Yes or No	Yes	Yes		
Pulse per Minute		100		
Mouth Temp. (P. M.)		99.2		
Sputum—Positive or Negative Note if flotation or guinea pig		Positive		
X-RAY: Childhood (1st Infection) or Adult (reinfection)		Adult		
X-RAY: Unilateral or Bilateral		Unilateral		
X-RAY: Findings—Increased, decreased, no change				
*				
PNEUMOTHORAX: Date of start				
PNEUMOTHORAX: Right or left				
PNEUMOTHORAX: Effective collapse				
PNEUMOTHORAX: Operation—Yes or No				
CHEST SURGERY: Oper., Ph., Th. or O				
CHEST SURGERY: Give dates of				
CHEST SURGERY: Effective collapse				
CHEST SURGERY: Operation—Yes or No				
Pul. Tb. NTA I II III (ABC)		IIIB		
Physician		Staff M.D.		

Extra Pulmonary Tuberculosis (date) Left Shoulder Joint, June 1932

*

Non-Tuberculous Diagnosis and Date Maxillary sinusitus 5-1-34

*

*Cause of Discharge: 1, Max. Care; 2, Ag. Advice; 3, Disciplinary; 4, with Consent; 5, Death; 6, Trans. to

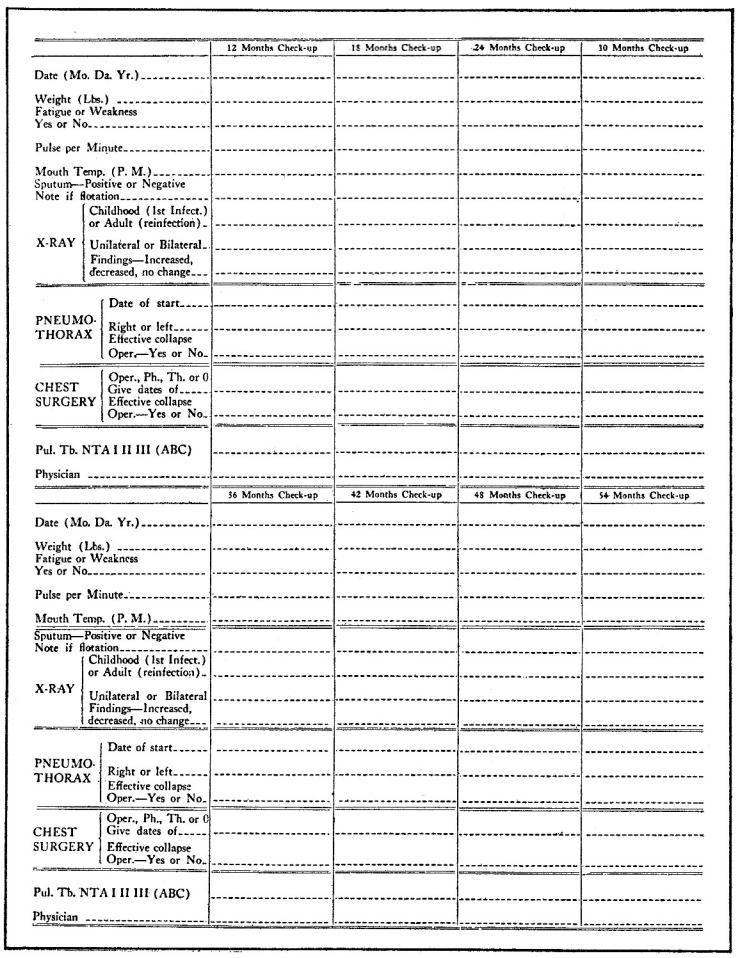
*Date for 1st follow-up (After discharge) Month Day Year with Dr. City or Town or at San.

Name Surname 2nd 1st

FIG. 165

Admission Sheet (Front)

family physician of the patient. The entire content of the admission record is coded and punched on this 80-column Hollerith card. The registration record is filed by sanitarium and sub-filed by case number, and the punched card is filed by admission month and sub-filed by sanitarium. The punched cards constitute a record of the current sanitarium population. It is necessary in the plan for the State Board of Control to have a six-month's follow-up of the essential clinical facts about the patient. Consequently the follow-up form illustrated in Fig. 167 is sent to the sanitarium each six months. This form carries the essential medical information required for a six-month's clinical check up and is so arranged as to be in the same order as the corresponding data gathered at admission on the registration sheet. Each month the appropriate cards of those cases involving the six-month interval of follow-up are selected, ordered in the sorting machine by sanitarium and by case number, and then the name and case number of those patients to be re-examined are listed on the follow-up form and mailed to the sanitariums.



	12 Months Check-up	18 Months Check-up	24 Months Check-up	30 Months Check-up
Date (Mo. Da. Yr.)				
Weight (Lbs.)				
Fatigue or Weakness Yes or No				
Pulse per Minute				
Mouth Temp. (P. M.)				
Sputum—Positive or Negative Note if flotation				
X-RAY: Childhood (1st Infect.) or Adult (reinfection)				
X-RAY: Unilateral or Bilateral				
X-RAY: Findings—Increased, decreased, no change				
PNEUMO-THORAX: Date of start				
PNEUMO-THORAX: Right or left				
PNEUMO-THORAX: Effective collapse				
PNEUMO-THORAX: Oper.—Yes or No				
CHEST SURGERY: Oper., Ph., Th. or 0				
CHEST SURGERY: Give dates of				
CHEST SURGERY: Effective collapse				
CHEST SURGERY: Oper.—Yes or No				
Pul. Tb. NTA I II III (ABC)				
Physician				

	36 Months Check-up	42 Months Check-up	48 Months Check-up	54 Months Check-up
Date (Mo. Da. Yr.)				
Weight (Lbs.)				
Fatigue or Weakness Yes or No				
Pulse per Minute				
Mouth Temp. (P. M.)				
Sputum—Positive or Negative Note if flotation				
X-RAY: Childhood (1st Infect.) or Adult (reinfection)				
X-RAY: Unilateral or Bilateral				
X-RAY: Findings—Increased, decreased, no change				
PNEUMO-THORAX: Date of start				
PNEUMO-THORAX: Right or left				
PNEUMO-THORAX: Effective collapse				
PNEUMO-THORAX: Oper.—Yes or No				
CHEST SURGERY: Oper., Ph., Th. or 0				
CHEST SURGERY: Give dates of				
CHEST SURGERY: Effective collapse				
CHEST SURGERY: Oper.—Yes or No				
Pul. Tb. NTA I II III (ABC)				
Physician				

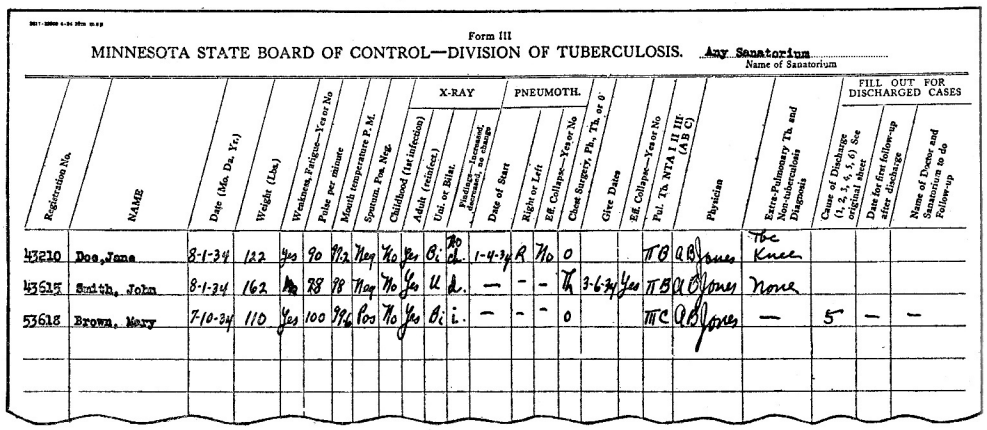
FIG. 166

Admission Sheet (Back)

As soon as the follow-up form is returned to the Division of Tuberculosis the clinical information is transferred to the patient's original registration record, and the card is punched for the new clinical data. Inquiry letters are sent to the sanitariums upon any incompleted cases or upon those cases whose eligibility for continued hospitalization is questioned by the Division of Tuberculosis.

On the back of the patient's registration sheet (See Fig. 166) there is room for the recording of eight six-month follow-up examinations so that the one registration sheet accommodates the necessary information over a four-year period. When the patient is finally discharged the registration sheet is completed and placed in a closed file which is arranged alphabetically by patients' names.

The entire plan can be carried out by the part time of one clerk. It serves to illustrate the manner in which follow-up clinical information of several institutions can be correlated by a central statistical control.



Form III

MINNESOTA STATE BOARD OF CONTROL—DIVISION OF TUBERCULOSIS. Any Sanatorium
Name of Sanatorium

Registration No.	NAME	Date (Mo. Da. Yr.)	Weight (Lbs.)	Weakness, Fatigue—Yes or No	Pulse per minute	Mouth temperature P. M.	Sputum Pos. Neg.	Childhood (Artificial)	X-RAY Adult (reinfect.)	X-RAY Uni. or Bilat.	X-RAY Readings—improved, arrested, or classification	X-RAY Date of Start	PNEUMOTH. Right or Left	PNEUMOTH. Eff. Collapse—Yes or No	PNEUMOTH. Close Surgery, Ph, Th, or 0	PNEUMOTH. Give Dates	Eff. Collapse—Yes or No	Pul. Tb. NTA I II III (A B C)	Physician	Extra-Pulmonary Tb. and Non-tuberculous Diagnosis	FILL OUT FOR DISCHARGED CASES: Cause of Discharge (1, 2, 3, 4, 5, 6) See original sheet	FILL OUT FOR DISCHARGED CASES: Date for first follow-up after discharge	FILL OUT FOR DISCHARGED CASES: Name of Doctor and Sanatorium to do Follow-up
43210	Doe, Jane	8-1-34	122	Yes	90	99⅖	Neg	No	Yes	Bi	Cl.	1-4-34	R	No	0			TB	QB Jones	Knee			
43515	Smith, John	8-1-34	162	No	78	98	Neg	No	Yes	U	d.	—	-	-	Th	3-6-34	Yes	TB	QA Jones	None			
53618	Brown, Mary	7-10-34	110	Yes	100	99⅘	Pos	No	Yes	Bi	i.	—	-	-	0			TC	QB Jones	—	5	—	—

FIG. 167

Follow-up Form

Cost Analysis and Inventory

Cost analysis and inventory is a hospital problem in which punched card methods are exceedingly useful particularly if the hospital is large. A knowledge of department budgets does not give the hospital administrator a strict control of *how goods are spent* in his institution. It should be possible for him at all times to know how clinical departments or nursing stations are spending their budget allotment, in terms of the kind and quantities of goods which they are using. If the expenditures are too large, he should be able to ask why excessive quantities of specific types of goods have been requisitioned. Conservation of materials results from such a control.

The following method is in use at the University of Minnesota Hospital:

Station numbers are assigned to all locations in the hospital from which supplies can be requisitioned, namely central supply rooms, nursing stations, department offices, operating rooms, etc. Station numbers are also assigned to the various locations from which the University Hospital can requisition or purchase supplies, namely the University store house, the University Farm, and cash purchases, etc.

All goods coming to the central hospital store room are of two types: those goods coming into the store room from outside the hospital and those returned unused from hospital stations. All goods leaving the central hospital store room are also of two types: those goods distributed to hospital stations or those sent back by the hospital to the vendor or to the University store house.

When a station desires to order an item from the hospital stockroom, an authorized person on such a station makes out a requisition slip in duplicate. The original is sent to the business office of the hospital for approval, and then to the hospital store room.

The store room is provided with a file of cards printed as shown in Fig. 168, which serve as cost-inventory cards of the goods in the store room. There is a cost-inventory card for each item carried in the store room. At the

Item Name						Unit Price	Item No.	Budget	Pack	Bin No.
Miscellaneous, Matches, Safety						.07	015 044	2411	Doz.	18
To	From	Balance	Station	Price	Date			2100		
67		67	12	4.69	6/8	✓				
	2	65	21	.14	6/11	✓				
60		125	12	4.02	6/12	✓				
	4	121	30	.28	6/14	✓				
	3	118	31	.21	6/18					
	12	106	8	.84	6/18					
20		126	25	1.40	6/24					

FIG. 168

Inventory Card

top of the cost-inventory card is certain information which is coded and punched in the last part of the card. In the example the item is *safety matches,* the unit price per pack is .07 per dozen, the item code number of 015044, the University Hospital budget number under which the item was purchased is 2411-2100, and the bin number is 18.

The store room clerk fills the requisition slip as soon as he receives it. In the example he supplies station 21 with two dozen boxes of matches on June 11, station 30 with four dozen boxes on June 14, station 31 with three dozen boxes on June 18, and station 8 with twelve dozen boxes on June 18. He calculates for each item the amount of money represented by this distribution of matches. On June 8 he enters sixty-seven dozen boxes and on June 12 sixty dozen, received from the University store house (station 12). The last balance, one hundred twenty-six dozen boxes of matches, is the current inventory in the store room. If a new order of matches should be purchased at a new unit price a new cost inventory card is started. No goods are distributed at the new price until the entire balance of those goods at the old price is expended.

If the requisition calls for some items which are not available in the store room those items are filled which are available and the unfilled items are copied on a "delayed requisition slip." The original requisition is returned to the station, and the probable date at which the items can be filled is indicated on the requisition. The "delayed requisitions" are filed in the stock room until they can be filled.

Once a week a punch operator goes over the cost inventory card file and punches a material distribution card for each item on the cost-inventory card. If the unit price is not available on the cost-inventory card due to delay in receiving the invoice she does not punch the material distribution card for this item until the following week. As she punches the material distribution cards she puts a check mark against the entries of the corresponding cost-inventory card. It is assumed in the example that the material distribution cards were brought to date on June 16.

In punching the material distribution cards the clerk punches the following information from the cost-inventory card: station number from which the goods are sent, the station to which the goods are going, the amount of goods, the price and the date. These cards are punched on the duplicating punch which permits the insertion of the cost-inventory card in order to have the punched information on unit price, item number, budget and pack transferred to the material distribution card automatically.

Printed tabulations are made from the material distribution card to show the distribution of goods by station, budget or item for any specified time period. From a printed list of what goes into or out of the store room and a knowledge of the previous inventory the new inventory can be calculated. Inventory of stations for those goods not expendable in character such as instruments and permanent equipment can be kept in a similar manner.

No difficulty was experienced in installing this cost accounting plan except in the construction of the material code numbers. The first major division of materials as coded has proved to be useful and is given as follows: housekeeping equipment, hardware and paints, office supplies and stationery, table and cooking supplies, foods, laboratory and x-ray supplies, apparels and linens, drugs, surgical supplies and miscellaneous.

It is possible to distribute personnel time and wages to stations in the same manner as goods are distributed in this plan if the problem is of sufficient complexity to warrant cost accounting.*

Collection or Accounts Receivable File

In any large private hospital the auditing of the accounts receivable file is a task of magnitude. Open accounts sometimes run for a score of years and mount into the thousands in number. The following adaptation of the Hollerith card is an economical method of maintaining a daily audit of the open accounts receivable.

The original entries of charges and credits on the patients bill are made on an individual account card or slip which is filed by case number of the patient. A Hollerith 80-column card is punched for each new charge, credit or write-off which is made on the patient's open account. These tabulating cards are first posted in the cash register at the same time as the hand-filed account cards are posted. After the Hollerith card is posted the following data are punched in it:

Case number
Geographical code by state, county and town
Occupation
Sex
Race
Age
Date by mo. and yr. of the first balance on the hand-filed account card
Date by mo. and yr. of the first open balance on the hand-filed account card

*A re-adaptation of this plan on the basis of alphabetic tabulating equipment is now in use at the University Hospital and may be secured by writing.

Date by day, mo. and yr. of the new balance
New debit
New cash credit
New credit write-off
New balance

The punch cards carrying this information are retained in the same order as they are posted on the cash register and at the end of the day they are passed through the printing tabulator and a printed list is obtained by case number which totals the debits, cash credits and credit write-offs. This list must check item for item with the cash register tape for the day.

The punched cards are then sorted by case number and separated into four groups: (1) those dealing with accounts having a previous open balance and still left as an open balance; (2) those with a previous open balance which are paid up; (3) those with a new balance or a balance from a reopened account; (4) those which deal with accounts opened and completely paid on the same day. After the punched cards have been ordered by case number, the new debit, credit, write-off and balance are printed and totaled for each of these four groups. The total for all four groups must check with the cash register total for the day. The punched cards are now ready to be filed in the open accounts. The punched card in group (1) is placed into the open account file and simultaneously the previously punched card on each of these accounts is removed from the file and listed by means of the printing tabulator. The previously punched cards in the open account file which correspond to the case number of the cards in group (2) are extracted from the file and listed by the printing tabulator. The punched cards in group (3) are inserted into the open accounts file. The completely paid up accounts represented by group (4) are not placed into the open accounts file. When the new balances in group (1) have been checked the total outstanding amount in the open account file is readjusted.

After this is accomplished, the previously punched cards which have been removed from the open accounts file and those newly punched cards falling in group (4) are destroyed. A ledger balance is kept daily of all totals computed under each group of cards.

This adaptation of Hollerith equipment to the collection file not only makes possible a daily audit but, by means of the selective sorter, and without disturbing the order of the open account punched cards, permits the business office management to select quickly all open accounts by occupation, geographical location of the patient, age, sex, case number, duration of account. This function is most useful when it becomes necessary to send a collecting agent to certain localities.

Special Studies

Probably the most useful of all functions of the Hollerith equipment is its adaptability to special studies. Special studies in almost every division of hospital administration as well as the clinical and pre-clinical branches have been made by coding the information collected and punching it upon Hollerith cards. The use of Hollerith equipment for this purpose has made it possible for the

record department to carry out special studies incidental to their routine work, which otherwise would have been prohibitive because of the amount of clerical time necessary for hand tabulation.

No attempt will be made in this chapter to describe any of these special studies since each one is a new and isolated tabulating problem.

Clerical time will be saved in any tabulating problem by coding and punching the data on Hollerith cards if the problem involves more than 50 to 75 cases and has more than 4 or 5 items which must be correlated with each other. If the number of cases runs into the hundreds it will pay to punch cards for the purpose of correlating as few as 3 items on each case. If the items on each case are more than ten to twelve in number and all manner of tabulations are desired between these various items it will be found time saving to code and punch as few as 30-40 cases before tabulating. Below these limits hand methods of tabulation are faster and preferable to machine methods.

Summary

It has been possible in this chapter to sketch but briefly the breadth of the field of hospital and clinical statistics and the important role played by tabulating equipment in their development. No space at all has been given to the description of the statistical method, a useful mathematical tool of analysis available to the hospital administrator, clinician and laboratory worker. This subject comes after satisfactory methods have been employed for the accumulation of data.*

Up to this time most of the research efforts in medicine have been directed at intensive study in steadily narrowing fields of clinical or laboratory interest. The science of statistical method and the adaptation of modern tabulating machinery are both valuable tools of analysis which will aid in extending research in these highly specialized fields of medicine. At the same time they make available to the medical scientist a useful method by which data from various fields of clinical interest can be inter-related.

* An introduction to this subject is given by Dunn, H. L. "Application of Statistical Methods in Physiology." Phys. Rev. Vol. IX, No. 2, Apr. 1929, pp. 275-398.

PART VI

Applications in Medical Research and in Hospitals

CHAPTER II

The Adair System of Punched Card Indexing for Obstetrics and Gynecology *

By

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MANY hospitals do not require an availability of medical statistical data, as the patients are admitted for some predominant condition for a short period of time only, and the institutions have no particular interest in accumulating data which may later be used for statistical and research purposes. This applies particularly to private hospitals serving the private patients of a relatively large staff of doctors and having no definite connection with any educational institution.

Any hospital which has a real interest in contributing to medical progress should be in a position to study and evaluate medical information to be obtained from its patrons, and to take an inventory of facts relative to the disease conditions and the results of its care and treatment of the patients.

The hospitals caring for maternity cases are especially in need of a system which will enable them to study and analyze the information which accumulates in the archives of the record room. The reasons why a maternity hospital especially should be in a position to study this sort of cumulative data are many, and some of these would apply to all hospitals. There are, however, some very special reasons which apply to hospitals caring for maternity cases.

Maternal care is of very vital sociologic and economic importance.

Maternal and fetal mortality have been practically stationary for many decades past and it is vital to understand the reasons for the methods of reducing this morbidity and mortality to a minimum.

There has been some argument as to the relative safety of home and hospital care for maternity patients. It is essential to know the facts and establish some basis for the development of institutional perfection.

Maternity patients are supervised for a relatively long time during pregnancy, labor and the postpartum period. They are apt to return for care during succeeding pregnancies. This means that many of them develop incidental and accidental complications which should be a matter of record so that the information may be available for both individual and group study.

* Much of the detailed work in the development of this system and in the preparation of this article was done by Doctors M. E. Davis, H. C. Hesseltine and the record librarian, Emma Jane Whipple.

There are always at least two individuals involved, mother and fetus, and it is desirable to correlate the information not only in terms of the subsequent life of the mother but also and especially with the future life of the infant.

It is not sufficient simply to tabulate a pregnancy, a labor, a puerperium, a stillbirth, a fetus, or an infant but all essential and pertinent data should be given in a form which would render this information easily available.

The Purpose of the System

To substitute a system which is more complete, accurate and less cumbersome than many plans of cross filing.

To insure greater completeness of the original records.

To provide for prompt filling out of the diagnostic sheet at the time the patient is discharged by the doctor.

To place the responsibility for completing the diagnostic record upon the doctor who is familiar with the case.

To record the maximum amount of information with a minimum of effort, and in a manner by which the data can be secured later largely through mechanical effort at a reasonable cost.

The Development of the System

The demand for an accurate and complete system of recording data relative to cases in a research and teaching clinic is obvious. The details should not be too cumbersome and the scheme should be workable without too great an expenditure of time.

The data should be so grouped that types of cases and conditions can be correlated and compiled and when desired various groups may be available for more detailed study. This study can be carried out by sorting these records by hand where small numbers are involved, or if in large numbers special punched cards can be set up for intensive study. These studies cannot be predicted in all of their details, and if they were, a primary punched card system involving so much detail would lead to inaccuracies and tremendous expenditure of time by those not vitally interested in these intensive investigations.

With these thoughts in mind the author elaborated the general plan, many details of which have been worked out by the staff of the Department of Obstetrics and Gynecology, especially Drs. M. Edward Davis and H. Close Hesseltine, and by Mrs. Emma Jane Whipple, the record librarian.

It should be clearly understood that this is not regarded in any sense as a fixed or perfect system and that many defects have been found by experience in its use. These are being gradually remedied and already some changes in details have been decided upon and will be incorporated in new summary sheets which will be published when the present supply is exhausted.

Thus far no fundamental errors have become apparent and the only alterations contemplated involve some re-arrangement of material and the correction of some obvious mistakes which crept into the first printing.

There are no gross errors, but there have been a few omissions which have been shown by experience. It will doubtless be a long time before this plan ceases to be in flux and attains anything like perfection. The fundamentals are, in our opinion, sound, though we recognize fully that the details would have to be modified to fulfill the needs of various types of institutions and that even maternity hospitals would have different desires which could be met by the classification and arrangement of the data on the summary sheet.

The Description of the System

The punched card system is a complete index of the patients who enter the hospital, their reason for being there, the course and treatment of the disease and the results thereof. In addition, it is a record of the techniques, procedures of the hospital, and other things which are necessary in the practice of medicine, as, for example, the group of facts incidental to the use of an operating room. Beyond this, the system makes available miscellaneous material concerning the social and economic status of the patients. It is not necessary to compare the value of this volume of material with the systems of indexing used in the past which recorded the diagnoses, dates of admission and discharge, sex, age and condition on discharge.

The punched card indexing gives the total number of the coded facts with the unit numbers of the histories containing this information.

Devising the system was in the nature of an experiment. The amount of material to be recorded seemed endless. The material was grouped under forty-one headings with subdivisions. Formerly, it was the duty of the intern to check the facts and it remained for the record librarian to transcribe them into the proper position on the punched card. Approximately six months was spent in discussing where this and that should be punched and what was meant by the intern in his checking and what really was to be considered a toxemia, an abortion, etc.

Careful revising has produced a summary sheet, size 8½ by 11 inches, printed on both sides. (See Figs. 169 and 170.) Blue paper is used so that it can be identified easily in the history. At the top of the front page, a small space has been reserved for recording the salient features of the case. This serves as a summary. The sheet contains essentially 80 columns arranged in order and all the code numbers in the 80 columns are plainly shown, except the first 14 columns which are indicated by column headings only. The record librarian is directly responsible for these data which are transcribed from the face sheet of the history to the card.

A code book has been made which defines in detail and with accuracy what is meant by each term used. This book takes the place of the old fashioned nomenclature of diseases. No error should be made in punching any given condition or state if the classification has been thoroughly followed. (See appendix, pp. 280 to 300, at the end of this chapter.)

At present, the resident checks the summary sheet from the history at the time of discharge, after which a staff member rechecks and endorses it. It is presumed that they are already familiar with the facts in the case and that it

L 010A
10-23-33-5000

The Chicago Lying-in Hospital and Dispensary
IN AFFILIATION WITH
The University of Chicago

Unit No. 104303

Name Doe, Mary Date of Admission 5-28-34 Delivery Discharge 6-10-34

FINAL DIAGNOSIS: Fibromyomata of uterus. S. ovarian cyst

PREGNANCY: Laceration cervix

LABOR: Total hysterectomy. S. Salpingo-oophorectomy

PUERPERIUM OR OPERATIONS: Febrile

Discharged on 12th day post-op in good condition

C D Arnett

Approved by F. J. Stein Attending Physician

1-6 UNIT NUMBER
7-9 DISCHARGE DATA
10 ADMISSION
11 RACE AND CLASS
12-13 YEAR OF BIRTH
14 SOCIAL STATE
15 COND. ON ADMISSION
0 ☐ MORIBUND
1 ☐ ACUTE OR EMERGENCY
2 ☐ OBSTETRIC
3 ☐ NOT IN LABOR
4 ☐ IN LABOR
5 ☐ POSTPARTUM
6 ☐ ATTEMPTED DELIVERY
7 ☒ GYNECOLOGIC
8 ☐ OTHER TYPES
9 ☐

16 SPECIAL DATA
0 ☐ VIRGIN
1 ☐ NULLIGRAVIDA
2 ☒ GRAVIDA
3 ☒ PARA
4 ☐ UNDETERMINED
5 ☐ MEDICO-LEGAL
6 ☐
7 ☐
8 ☐
9 ☐

17 PAST HISTORY
0 ☐ ABD. OP. NOT OB. OR GYN.
1 ☐ ABD. OP. GYN.
2 ☐ VAGINAL OP. GYN.
3 ☐ CESAREAN SECTION
4 ☐ ABD. OP. OBST.
5 ☐ FORCEP. VERSION, BREECH
6 ☐ VAGINAL OP. OBST.
7 ☐ STILLBIRTHS
8 ☐ TREATED FOR STERILITY
9 ☐ X-RAY, RADIUM

18 PAST HISTORY—Cont.
0 ☐ ABORTION (INTENT'L)
1 ☐ ABORTION (UNINTENT'L)
2 ☐ SEPSIS (PUERPERAL OR POST-ABORTAL)
3 ☐ HEMORRHAGE OR SHOCK
4 ☐ PLAC. PREV. ABRUPTIO
5 ☐ TOXEMIA
6 ☐ HYPEREMESIS GRAVID
7 ☐ VULVAL PRURITIS
8 ☐ GYN. CONDITION
9 ☐

19 PELVIS
0 ☐ NORMAL
1 ☐ CONTRACTED CONG.
2 ☐ CONTRACTED ACQUIRED
3 ☐ CONTRACTED MISC.
4 ☐ UNDETERMINED
5 ☐
6 ☐
7 ☐
8 ☐
9 ☐

20 TOXEMIA
0 ☐ HYPERTENSION ESSENT.
1 ☐ NEPHRITIS
2 ☐ NEPHROSIS
3 ☐ PRE-ECLAMPSIA
4 ☐ ECLAMPSIA
5 ☐ HYPEREMESIS
6 ☐ MISCELLANEOUS
7 ☐
8 ☐
9 ☐

21 LABOR
0 ☐ SPONTANEOUS ONSET
1 ☐ FALSE LABOR
2 ☐ DRUG INDUCTION
3 ☐ DRUG INDUCTION FAILED
4 ☐ MECHANICAL INDUCTION
5 ☐ " " FAILED
6 ☐ SHORT LABOR
7 ☐ AVERAGE LABOR
8 ☐ LONG LABOR
9 ☐

22 LABOR—Continued
0 ☐ SPONTAN. TERMINATION
1 ☐ ARTIFICIAL
2 ☐ BLOOD LOSS—SMALL
3 ☐ BLOOD LOSS—MODERATE
4 ☐ BLOOD LOSS—EXCESSIVE
5 ☐ BLOOD LOSS—100 C.C. MEAS.
6 ☐ BLOOD LOSS—100-500 C.C.
7 ☐ BLOOD LOSS—OVER 500 C.C.
8 ☐
9 ☐

23 MEMBRANES
0 ☐ RUPTURE—SPONTANEOUS
1 ☐ RUPTURE—ARTIF. MEANS
2 ☐ RUPTURE—PREMATURE
3 ☐ RUPTURE—EARLY
4 ☐ RUPTURE—USUAL
5 ☐ RUPTURE—DELAYED
6 ☐
7 ☐
8 ☐
9 ☐

24 INLET PRESENT., POS.
0 ☐ OCCIPUT
1 ☐ OTHER CEPHALIC
2 ☐ BREECH
3 ☐ TRANSVERSE
4 ☐ RIGHT
5 ☐ LEFT
6 ☐ ANTERIOR
7 ☐ TRANSVERSE
8 ☐ POSTERIOR
9 ☐ MISCELLANEOUS

25 OUTLET PRESENT., POSL
0 ☐ OCCIPUT
1 ☐ OTHER CEPHALIC
2 ☐ BREECH
3 ☐ TRANSVERSE
4 ☐ RIGHT
5 ☐ LEFT
6 ☐ ANTERIOR
7 ☐ TRANSVERSE
8 ☐ POSTERIOR
9 ☐ MISCELLANEOUS

26 PLACENTA, CORD, AMNI.
0 ☐ PLACENTA, ABNORMAL
1 ☐ PLACENTA-PRAEVIA
2 ☐ ABRUPTIO PLACENTAE
3 ☐ OTHER ABNORMALITIES
4 ☐ CORD ENTANGLEMENT
5 ☐ CORD PROLAPSE
6 ☐ CORD—MISCELLANEOUS
7 ☐ AMNIOTIC FL'D.—NORM.
8 ☐ AMNIOTIC FLUID—EXC.
9 ☐ AMNIOTIC FLUID—MISC.
10 ☐ DLIGOHYDRAMNIOS (LESS THAN 100 C.C.)

27 OPERAT., PRIMARY OBS.
28 0 ☐ EPISIOTOMY
1 ☐ DUHRSSEN'S INCISIONS
2 ☐ MANUAL REM. OF PLAC.
3 ☐ UTERINE TAMPONADE
4 ☐ LOW FORCEPS
5 ☐ MID FORCEPS
6 ☐ HIGH FORCEPS
7 ☐ MANUAL ROTATION
8 ☐ FORCEPS ROTATION
9 ☐ " AFTERCOM. HEAD

29 OPERATIONS—Continued
0 ☐ VERSION, NO EXTRACTION
1 ☐ " AND EXTRACTION
2 ☐ CEPHALIC VERSION
3 ☐ CONVERSION
4 ☐ BREECH EXTRACTION
5 ☐ DESTRUCTIVE OPERATS.
6 ☐ HYSTEROTOMY
7 ☐ LAPAROTACHELOTOMY
8 ☐ CLASSIC. OTHER SECTIONS
9 ☐ VAGINAL CESAREAN

30 TIME, OBST. OPERATION
31 0 ☐ BEFORE ONSET OF LABOR
1 ☐ DURING FIRST STAGE
2 ☐ DURING SECOND STAGE
3 ☐ DURING THIRD STAGE
4 ☐ POSTPARTUM PERIOD
5 ☐
6 ☐
7 ☐
8 ☐
9 ☐

32 BIRTH WEIGHT
0 ☐ LESS THAN 1,000 GRAMS
1 ☐ 1,001 TO 1,500 GRAMS
2 ☐ 1,501 TO 2,000 GRAMS
3 ☐ 2,001 TO 2,500 GRAMS
4 ☐ 2,501 TO 3,500 GRAMS
5 ☐ 3,501 TO 4,500 GRAMS
6 ☐ 4,501 TO 5,000 GRAMS
7 ☐ 5,001 OR MORE GRAMS
8 ☐
9 ☐

33 FETUS VIABILITY
0 ☐ ABORTION
1 ☐ PREMATURE
2 ☐ TERM
3 ☐ EXCESSIVE SIZE
4 ☐ ANTENATAL DEATH
5 ☐ INTRANATAL DEATH
6 ☐ POSTNATAL DEATH
7 ☐ NEONATAL DEATH
8 ☐ LIVING BIRTH
9 ☐ AUTOPSY ON FETUS OR NEWBORN

34 FETUS NEWBORN—DIS.
0 ☐ SUFFOCATION, ASPIRATION, ETC.
1 ☐ TRAUMA—MAJOR
2 ☐ TRAUMA—MINOR
3 ☐ INFECTION—CONGENITAL
4 ☐ " —OTHER MAJOR
5 ☐ INFECTION—MINOR
6 ☐ PREMAT. AND/OR IMMAT.
7 ☐ CONGEN'L STATE—MAJOR
8 ☐ CONGEN'L STATE—MINOR
9 ☐ MISC. AND ICTERUS NEON.

35 SEX, FEEDINGS, STATE
0 ☐ MALE (SINGLE PREG.)
1 ☐ FEMALE (SINGLE PREG.)
2 ☐ MALE (MULTIPLE PREG.)
3 ☐ FEMALE (MULTIPLE PREG.)
4 ☐ FEEDING—BREAST
5 ☐ FEEDING—ARTIFICIAL
6 ☐ FEEDING—COMBINATION
7 ☐ DISCHARGE SATISFAC.
8 ☐ DISCHARGE, ALIVE BUT UNSATISFAC. OR TRANS. TO OTHER SERVICE
9 ☐ CIRCUMCISED BEFORE LEAVING HOSPITAL

36 PERVERTED PREGN'CY
0 ☐ ABORTION—COMPLETE
1 ☐ " —THREATENED
2 ☐ " —INCOMP. 1ST TRI.
3 ☐ " —INCOMP. 2ND TRI.
4 ☐ " —INTENT'L THERAP.
5 ☐ " — " NON-THERAP.
6 ☐ " —UNINTENTIONAL
7 ☐ ABORTION—MISSED
8 ☐ ECTOPIC
9 ☐ HYDATIDIFORM MOLE AND/OR CHORIOEPITHELIOMA

37 MENSTRUATION
0 ☐ ABNORMAL ONSET CATAMENIA
1 ☐ HYPOMENORRHEA, SCANT
2 ☐ HYPERMENORRHEA (MENORRHAGIA)
3 ☐ POLYMENORRHEA (METRORRHAGIA)
4 ☐ AMENORRHEA
5 ☐ IRREGULAR
6 ☐ VICARIOUS
7 ☐ DYSMENORRHEA
8 ☐
9 ☐

38 STERIL'Y, MENOPAUSE
0 ☐ MALE
1 ☐ FEMALE
2 ☐ FEMALE—TUBAL
3 ☐ FEMALE—OTHER EXCEPT ENDOCRINAL
4 ☐ FEMALE—ENDOCRINAL
5 ☐
6 ☐ MENOPAUSE—PHYSIOLOG.
7 ☐ MENOPAUSE—ARTIFICIAL
8 ☐ MENOPAUSE—ABNORMAL
9 ☐ POST-MENOPAUSAL BLEED.

39 MALPOSIT. UTERUS, ETC.
0 ☒ 1° AND 2° RETROVERSION
1 ☐ 3° RETROVERSION
2 ☐ POSTPARTUM RETROVER
3 ☐ ADHERENT RETROVER.
4 ☐ SYMPTOMS FROM RETRO.
5 ☐ 1° AND 2° PROLAPSE
6 ☐ 3° PROLAPSE
7 ☐ INVERSION OF UTERUS
8 ☐ OTHER MALPOSITIONS
9 ☐ ABNORMAL DISPLACEMENT OF ADNEXA

40 LACERATION, ETC.
0 ☐ CYSTOCELE
1 ☐ RECTOCELE
2 ☐ URETHROCELE, CARUNCLE, PROLAPSE URETH.
3 ☐ ENTEROCELE AND/OR VAGINAL HERNIA
4 ☐ FISTULA
5 ☐ EVERSION, ECTROPION OF CERVIX
6 ☒ EROSION OF CERVIX
7 ☐
8 ☐
9 ☐

41 LACERATION—Continued
0 ☐ EPISIOTOMY UNREPAIRED
1 ☐ PERIN. LAC.—REC. (1° & 2°)
2 ☐ " " —OLD (1° & 2°)
3 ☐ " " —RECENT (3°)
4 ☐ " " —OLD (3°)
5 ☐ VAG. LAC. —RECENT
6 ☐ " " —OLD
7 ☐ CERVICAL LAC.—RECENT
8 ☒ " —OLD
9 ☐ UTERINE RUPTURE

42 MISC. DISTURBANCES
0 ☐ FIBROSIS UTERI
1 ☐ SUBINVOLUTION, UTERUS
2 ☐ HYPERPLASIA ENDOMETRIUM
3 ☐ POLYPS AND POLYPOSIS
4 ☐ KRAUROSIS VULVAE
5 ☐ SENILE ATROPHY
6 ☐ FOREIGN BODY IN GENERATIVE TRACT OR PELVIS
7 ☐
8 ☐ RETURN CASE—NO ADDITIONAL DIAGNOSIS
9 ☐ GYN. AND/OR OBST. STATES ABSENT NO GYN. OR OBST. DIAG. NORMAL PELVIS

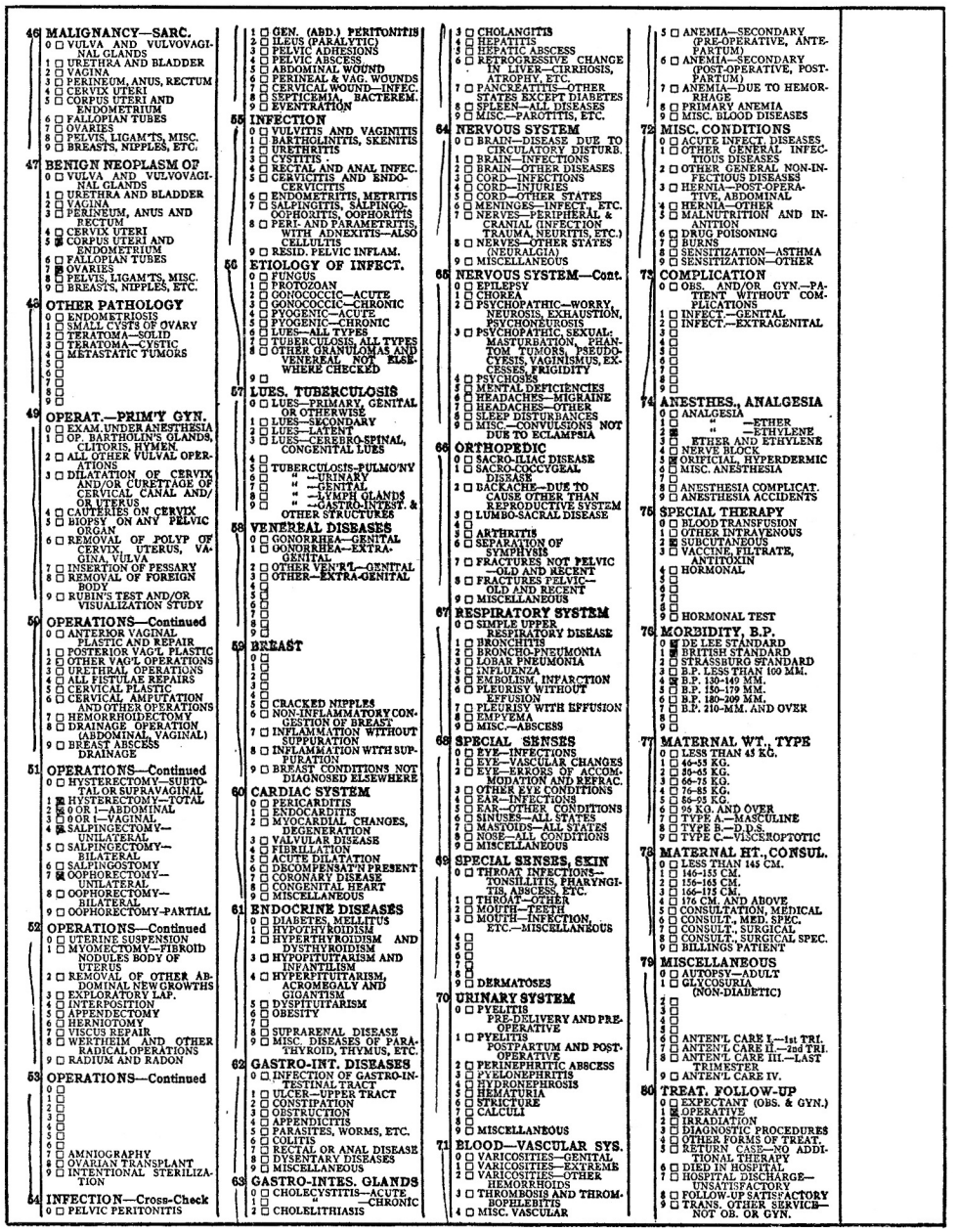
43 MISC. DISTURBANCES
0 ☐
1 ☐
2 ☐
3 ☐
4 ☐ PRURITIS VULVAE
5 ☐
6 ☐ HEMATOMETRA LOCHIOMETRA
7 ☐
8 ☐ HEMATOMA
9 ☐ MISCELLANEOUS

44 ANOMALY, DEFECT, ETC.
0 ☐ VULVA AND VULVOVAGINAL GLANDS
1 ☐ URETHRA AND BLADDER
2 ☐ VAGINA
3 ☐ PERINEUM, ANUS, RECTUM
4 ☐ CERVIX UTERI
5 ☐ CORPUS UTERI AND ENDOMETRIUM
6 ☐ FALLOPIAN TUBES
7 ☐ OVARIES
8 ☐ PELVIS, LIGAM'TS MISC.
9 ☐ BREASTS, NIPPLES, ETC.

45 MALIGNANCY—CARC.
0 ☐ VULVA AND VULVOVAGINAL GLANDS
1 ☐ URETHRA AND BLADDER
2 ☐ VAGINA
3 ☐ PERINEUM, ANUS AND RECTUM
4 ☐ CERVIX UTERI
5 ☐ CORPUS UTERI AND ENDOMETRIUM
6 ☐ FALLOPIAN TUBES
7 ☐ OVARIES
8 ☐ PELVIS, LIGAM'TS MISC.
9 ☐ BREASTS, NIPPLES, ETC.

FIG. 169

Summary Sheet (Front)



46 MALIGNANCY—SARC.
0 ☐ VULVA AND VULVOVAGINAL GLANDS
1 ☐ URETHRA AND BLADDER
2 ☐ VAGINA
3 ☐ PERINEUM, ANUS, RECTUM
4 ☐ CERVIX UTERI
5 ☐ CORPUS UTERI AND ENDOMETRIUM
6 ☐ FALLOPIAN TUBES
7 ☐ OVARIES
8 ☐ PELVIS, LIGAM'TS, MISC.
9 ☐ BREASTS, NIPPLES, ETC.

47 BENIGN NEOPLASM OF
0 ☐ VULVA AND VULVOVAGINAL GLANDS
1 ☐ URETHRA AND BLADDER
2 ☐ VAGINA
3 ☐ PERINEUM, ANUS AND RECTUM
4 ☐ CERVIX UTERI
5 ☒ CORPUS UTERI AND ENDOMETRIUM
6 ☐ FALLOPIAN TUBES
7 ☒ OVARIES
8 ☐ PELVIS, LIGAM'TS, MISC.
9 ☐ BREASTS, NIPPLES, ETC.

48 OTHER PATHOLOGY
0 ☐ ENDOMETRIOSIS
1 ☐ SMALL CYSTS OF OVARY
2 ☐ TERATOMA—SOLID
3 ☐ TERATOMA—CYSTIC
4 ☐ METASTATIC TUMORS
5 ☐
6 ☐
7 ☐
8 ☐
9 ☐

49 OPERAT.—PRIM'Y GYN.
0 ☐ EXAM. UNDER ANESTHESIA
1 ☐ OP. BARTHOLIN'S GLANDS, CLITORIS, HYMEN
2 ☐ ALL OTHER VULVAL OPERATIONS
3 ☐ DILATATION OF CERVIX AND/OR CURETTAGE OF CERVICAL CANAL AND/OR UTERUS
4 ☐ CAUTERIES ON CERVIX
5 ☐ BIOPSY ON ANY PELVIC ORGAN
6 ☐ REMOVAL OF POLYP OF CERVIX, UTERUS, VAGINA, VULVA
7 ☐ INSERTION OF PESSARY
8 ☐ REMOVAL OF FOREIGN BODY
9 ☐ RUBIN'S TEST AND/OR VISUALIZATION STUDY

50 OPERATIONS—Continued
0 ☐ ANTERIOR VAGINAL PLASTIC AND REPAIR
1 ☐ POSTERIOR VAG'L PLASTIC
2 ☐ OTHER VAG'L OPERATIONS
3 ☐ URETHRAL OPERATIONS
4 ☐ ALL FISTULAE REPAIRS
5 ☐ CERVICAL PLASTIC
6 ☐ CERVICAL AMPUTATION AND OTHER OPERATIONS
7 ☐ HEMORRHOIDECTOMY
8 ☐ DRAINAGE OPERATION (ABDOMINAL, VAGINAL)
9 ☐ BREAST ABSCESS DRAINAGE

51 OPERATIONS—Continued
0 ☐ HYSTERECTOMY—SUBTOTAL OR SUPRAVAGINAL
1 ☒ HYSTERECTOMY—TOTAL
2 ☒ 0 OR 1—ABDOMINAL
3 ☐ 0 OR 1—VAGINAL
4 ☒ SALPINGECTOMY—UNILATERAL
5 ☐ SALPINGECTOMY—BILATERAL
6 ☐ SALPINGOSTOMY
7 ☒ OOPHORECTOMY—UNILATERAL
8 ☐ OOPHORECTOMY—BILATERAL
9 ☐ OOPHORECTOMY-PARTIAL

52 OPERATIONS—Continued
0 ☐ UTERINE SUSPENSION
1 ☐ MYOMECTOMY—FIBROID NODULES BODY OF UTERUS
2 ☐ REMOVAL OF OTHER ABDOMINAL NEW GROWTHS
3 ☐ EXPLORATORY LAP.
4 ☐ INTERPOSITION
5 ☐ APPENDECTOMY
6 ☐ HERNIOTOMY
7 ☐ VISCUS REPAIR
8 ☐ WERTHEIM AND OTHER RADICAL OPERATIONS
9 ☐ RADIUM AND RADON

53 OPERATIONS—Continued
0 ☐
1 ☐
2 ☐
3 ☐
4 ☐
5 ☐
6 ☐
7 ☐ AMNIOGRAPHY
8 ☐ OVARIAN TRANSPLANT
9 ☐ INTENTIONAL STERILIZATION

54 INFECTION—Cross-Check
0 ☐ PELVIC PERITONITIS
1 ☐ GEN. (ABD.) PERITONITIS
2 ☐ ILEUS (PARALYTIC)
3 ☐ PELVIC ADHESIONS
4 ☐ PELVIC ABSCESS
5 ☐ ABDOMINAL WOUND
6 ☐ PERINEAL & VAG. WOUNDS
7 ☐ CERVICAL WOUND—INFEC.
8 ☐ SEPTICEMIA BACTEREM.
9 ☐ EVENTRATION

55 INFECTION
0 ☐ VULVITIS AND VAGINITIS
1 ☐ BARTHOLINITIS, SKENITIS
2 ☐ URETHRITIS
3 ☐ CYSTITIS
4 ☐ RECTAL AND ANAL INFEC.
5 ☐ CERVICITIS AND ENDOCERVICITIS
6 ☐ ENDOMETRITIS, METRITIS
7 ☐ SALPINGITIS, SALPINGO-OOPHORITIS, OOPHORITIS
8 ☐ PERI- AND PARAMETRITIS, WITH ADNEXITIS—ALSO CELLULITIS
9 ☐ RESID. PELVIC INFLAM.

56 ETIOLOGY OF INFECT.
0 ☐ FUNGUS
1 ☐ PROTOZOAN
2 ☐ GONOCOCCIC—ACUTE
3 ☐ GONOCOCCIC—CHRONIC
4 ☐ PYOGENIC—ACUTE
5 ☐ PYOGENIC—CHRONIC
6 ☐ LUES—ALL TYPES
7 ☐ TUBERCULOSIS, ALL TYPES
8 ☐ OTHER GRANULOMAS AND VENEREAL NOT ELSEWHERE CHECKED
9 ☐

57 LUES, TUBERCULOSIS
0 ☐ LUES—PRIMARY, GENITAL OR OTHERWISE
1 ☐ LUES—SECONDARY
2 ☐ LUES—LATENT
3 ☐ LUES—CEREBRO-SPINAL, CONGENITAL LUES
4 ☐
5 ☐ TUBERCULOSIS-PULMO'NY
6 ☐ " —URINARY
7 ☐ " —GENITAL
8 ☐ " —LYMPH GLANDS
9 ☐ " —GASTRO-INTEST. & OTHER STRUCTURES

58 VENEREAL DISEASES
0 ☐ GONORRHEA—GENITAL
1 ☐ GONORRHEA—EXTRA-GENITAL
2 ☐ OTHER VEN'R'L—GENITAL
3 ☐ OTHER—EXTRA-GENITAL
4 ☐
5 ☐
6 ☐
7 ☐
8 ☐
9 ☐

59 BREAST
0 ☐
1 ☐
2 ☐
3 ☐
4 ☐
5 ☐ CRACKED NIPPLES
6 ☐ NON-INFLAMMATORY CONGESTION OF BREAST
7 ☐ INFLAMMATION WITHOUT SUPPURATION
8 ☐ INFLAMMATION WITH SUPPURATION
9 ☐ BREAST CONDITIONS NOT DIAGNOSED ELSEWHERE

60 CARDIAC SYSTEM
0 ☐ PERICARDITIS
1 ☐ ENDOCARDITIS
2 ☐ MYOCARDIAL CHANGES, DEGENERATION
3 ☐ VALVULAR DISEASE
4 ☐ FIBRILLATION
5 ☐ ACUTE DILATATION
6 ☐ DECOMPENSAT'N PRESENT
7 ☐ CORONARY DISEASE
8 ☐ CONGENITAL HEART
9 ☐ MISCELLANEOUS

61 ENDOCRINE DISEASES
0 ☐ DIABETES, MELLITUS
1 ☐ HYPOTHYROIDISM
2 ☐ HYPERTHYROIDISM AND DYSTHYROIDISM
3 ☐ HYPOPITUITARISM AND INFANTILISM
4 ☐ HYPERPITUITARISM, ACROMEGALY AND GIGANTISM
5 ☐ DYSPITUITARISM
6 ☐ OBESITY
7 ☐
8 ☐ SUPRARENAL DISEASE
9 ☐ MISC. DISEASES OF PARATHYROID, THYMUS, ETC.

62 GASTRO-INT. DISEASES
0 ☐ INFECTION OF GASTRO-INTESTINAL TRACT
1 ☐ ULCER—UPPER TRACT
2 ☐ CONSTIPATION
3 ☐ OBSTRUCTION
4 ☐ APPENDICITIS
5 ☐ PARASITES, WORMS, ETC.
6 ☐ COLITIS
7 ☐ RECTAL OR ANAL DISEASE
8 ☐ DYSENTARY DISEASES
9 ☐ MISCELLANEOUS

63 GASTRO-INTES. GLANDS
0 ☐ CHOLECYSTITIS—ACUTE
1 ☐ " —CHRONIC
2 ☐ CHOLELITHIASIS
3 ☐ CHOLANGITIS
4 ☐ HEPATITIS
5 ☐ HEPATIC ABSCESS
6 ☐ RETROGRESSIVE CHANGE IN LIVER—CIRRHOSIS, ATROPHY, ETC.
7 ☐ PANCREATITIS—OTHER STATES EXCEPT DIABETES
8 ☐ SPLEEN—ALL DISEASES
9 ☐ MISC.—PAROTITIS, ETC.

64 NERVOUS SYSTEM
0 ☐ BRAIN—DISEASE DUE TO CIRCULATORY DISTURB.
1 ☐ BRAIN—INFECTIONS
2 ☐ BRAIN—OTHER DISEASES
3 ☐ CORD—INFECTIONS
4 ☐ CORD—INJURIES
5 ☐ CORD—OTHER STATES
6 ☐ MENINGES—INFECT. ETC.
7 ☐ NERVES—PERIPHERAL & CRANIAL (INFECTION TRAUMA, NEURITIS, ETC.)
8 ☐ NERVES—OTHER STATES (NEURALGIA)
9 ☐ MISCELLANEOUS

65 NERVOUS SYSTEM—Cont.
0 ☐ EPILEPSY
1 ☐ CHOREA
2 ☐ PSYCHOPATHIC—WORRY, NEUROSIS, EXHAUSTION, PSYCHONEUROSIS
3 ☐ PSYCHOPATHIC, SEXUAL: MASTURBATION, PHANTOM TUMORS, PSEUDOCYESIS, VAGINISMUS, EXCESSES, FRIGIDITY
4 ☐ PSYCHOSES
5 ☐ MENTAL DEFICIENCIES
6 ☐ HEADACHES—MIGRAINE
7 ☐ HEADACHES—OTHER
8 ☐ SLEEP DISTURBANCES
9 ☐ MISC.—CONVULSIONS NOT DUE TO ECLAMPSIA

66 ORTHOPEDIC
0 ☐ SACRO-ILIAC DISEASE
1 ☐ SACRO-COCCYGEAL DISEASE
2 ☐ BACKACHE—DUE TO CAUSE OTHER THAN REPRODUCTIVE SYSTEM
3 ☐ LUMBO-SACRAL DISEASE
4 ☐
5 ☐ ARTHRITIS
6 ☐ SEPARATION OF SYMPHYSIS
7 ☐ FRACTURES NOT PELVIC —OLD AND RECENT
8 ☐ FRACTURES PELVIC—OLD AND RECENT
9 ☐ MISCELLANEOUS

67 RESPIRATORY SYSTEM
0 ☐ SIMPLE UPPER RESPIRATORY DISEASE
1 ☐ BRONCHITIS
2 ☐ BRONCHO-PNEUMONIA
3 ☐ LOBAR PNEUMONIA
4 ☐ INFLUENZA
5 ☐ EMBOLISM, INFARCTION
6 ☐ PLEURSY WITHOUT EFFUSION
7 ☐ PLEURISY WITH EFFUSION
8 ☐ EMPYEMA
9 ☐ MISC.—ABSCESS

68 SPECIAL SENSES
0 ☐ EYE—INFECTIONS
1 ☐ EYE—VASCULAR CHANGES
2 ☐ EYE—ERRORS OF ACCOMMODATION AND REFRAC.
3 ☐ OTHER EYE CONDITIONS
4 ☐ EAR—INFECTIONS
5 ☐ EAR—OTHER CONDITIONS
6 ☐ SINUSES—ALL STATES
7 ☐ MASTOID—ALL STATES
8 ☐ NOSE—ALL CONDITIONS
9 ☐ MISCELLANEOUS

69 SPECIAL SENSES, SKIN
0 ☐ THROAT INFECTIONS—TONSILLITIS, PHARYNGITIS, ABSCESS, ETC.
1 ☐ THROAT—OTHER
2 ☐ MOUTH—TEETH
3 ☐ MOUTH—INFECTION, ETC.—MISCELLANEOUS
4 ☐
5 ☐
6 ☐
7 ☐
8 ☐
9 ☐ DERMATOSES

70 URINARY SYSTEM
0 ☐ PYELITIS PRE-DELIVERY AND PRE-OPERATIVE
1 ☐ PYELITIS POST-PARTUM AND POST-OPERATIVE
2 ☐ PERINEPHRITIC ABSCESS
3 ☐ PYELONEPHRITIS
4 ☐ HYDRONEPHROSIS
5 ☐ HEMATURIA
6 ☐ STRICTURE
7 ☐ CALCULI
8 ☐
9 ☐ MISCELLANEOUS

71 BLOOD—VASCULAR SYS.
0 ☐ VARICOSITIES—GENITAL
1 ☐ VARICOSITIES—EXTREMS
2 ☐ VARICOSITIES—OTHER HEMORRHOIDS
3 ☐ THROMBOSIS AND THROMBOPHLEBITIS
4 ☐ MISC. VASCULAR
5 ☐ ANEMIA—SECONDARY (PRE-OPERATIVE, ANTE-PARTUM)
6 ☐ ANEMIA—SECONDARY (POST-OPERATIVE, POST-PARTUM)
7 ☐ ANEMIA—DUE TO HEMORRHAGE
8 ☐ PRIMARY ANEMIA
9 ☐ MISC. BLOOD DISEASES

72 MISC. CONDITIONS
0 ☐ ACUTE INFECT. DISEASES
1 ☐ OTHER GENERAL INFECTIOUS DISEASES
2 ☐ OTHER GENERAL NON-INFECTIOUS DISEASES
3 ☐ HERNIA—POST-OPERATIVE, ABDOMINAL
4 ☐ HERNIA—OTHER
5 ☐ MALNUTRITION AND INANITION
6 ☐ DRUG POISONING
7 ☐ BURNS
8 ☐ SENSITIZATION—ASTHMA
9 ☐ SENSITIZATION—OTHER

73 COMPLICATION
0 ☐ OBS. AND/OR GYN.—PATIENT WITHOUT COMPLICATIONS
1 ☐ INFECT.—GENITAL
2 ☐ INFECT.—EXTRAGENITAL
3 ☐
4 ☐
5 ☐
6 ☐
7 ☐
8 ☐
9 ☐

74 ANESTHES., ANALGESIA
0 ☐ ANALGESIA
1 ☐ " —ETHER
2 ☒ " —ETHYLENE
3 ☐ ETHER AND ETHYLENE
4 ☐ NERVE BLOCK
5 ☒ SPINAL, HYPERDERMIC
6 ☐ MISC. ANESTHESIA
7 ☐
8 ☐ ANESTHESIA COMPLICAT.
9 ☐ ANESTHESIA ACCIDENTS

75 SPECIAL THERAPY
0 ☐ BLOOD TRANSFUSION
1 ☐ OTHER INTRAVENOUS
2 ☒ SUBCUTANEOUS
3 ☐ VACCINE, FILTRATE, ANTITOXIN
4 ☐ HORMONAL
5 ☐
6 ☐
7 ☐
8 ☐
9 ☐ HORMONAL TEST

76 MORBIDITY, B.P.
0 ☒ DE LEE STANDARD
1 ☒ BRITISH STANDARD
2 ☐ STRASSBURG STANDARD
3 ☐ B.P. LESS THAN 100 MM.
4 ☒ B.P. 130–149 MM.
5 ☐ B.P. 150–179 MM.
6 ☐ B.P. 180–209 MM.
7 ☐ B.P. 210–MM. AND OVER
8 ☐
9 ☐

77 MATERNAL WT., TYPE
0 ☐ LESS THAN 45 KG.
1 ☐ 46–55 KG.
2 ☐ 56–65 KG.
3 ☐ 66–75 KG.
4 ☐ 76–85 KG.
5 ☐ 86–95 KG.
6 ☐ 96 KG. AND OVER
7 ☐ TYPE A.—MASCULINE
8 ☐ TYPE B.—N.D.S.
9 ☐ TYPE C.—VISCEROPTOTIC

78 MATERNAL HT., CONSUL.
0 ☐ LESS THAN 145 CM.
1 ☐ 146–155 CM.
2 ☐ 156–165 CM.
3 ☐ 166–175 CM.
4 ☐ 176 CM. AND ABOVE
5 ☐ CONSULTATION, MEDICAL
6 ☐ CONSULT., MED. SPEC.
7 ☐ CONSULT., SURGICAL
8 ☐ CONSULT., SURGICAL SPEC.
9 ☐ BILLINGS PATIENT

79 MISCELLANEOUS
0 ☐ AUTOPSY—ADULT
1 ☐ GLYCOSURIA (NON-DIABETIC)
2 ☐
3 ☐
4 ☐
5 ☐
6 ☐ ANTEN'L CARE I.—1st TRI.
7 ☐ ANTEN'L CARE II.—2nd TRI.
8 ☐ ANTEN'L CARE III.—LAST TRIMESTER
9 ☐ ANTEN'L CARE IV.

80 TREAT. FOLLOW-UP
0 ☐ EXPECTANT (OBS. & GYN.)
1 ☒ OPERATIVE
2 ☐ IRRADIATION
3 ☐ DIAGNOSTIC PROCEDURES
4 ☐ OTHER FORMS OF TREAT.
5 ☐ RETURN CASE—NO ADDITIONAL THERAPY
6 ☐ DIED IN HOSPITAL
7 ☐ HOSPITAL DISCHARGE—UNSATISFACTORY
8 ☐ FOLLOW-UP SATISFACTORY
9 ☐ TRANS. OTHER SERVICE—NOT OB. OR GYN.

FIG. 170

Summary Sheet (Back)

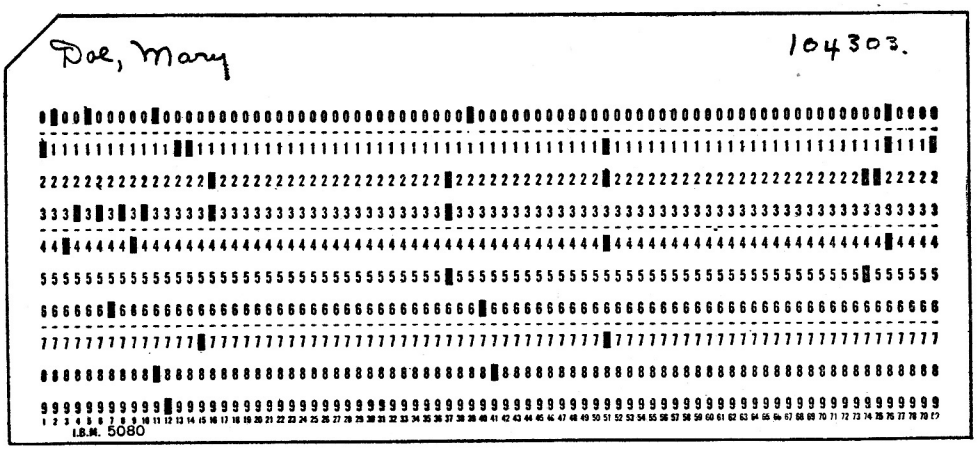


FIG. 171

Punched Cross Index Card

should be no great task for them to check the blue sheet. To conserve their time and facilitate their work, the material was carefully arranged and the sequence follows that usually observed by a doctor studying the case of his patient. In addition, the material is correlated in position with the content and form of the histories. The Obstetric and Gynecologic services use the same summary sheet. The facts are in somewhat the following form.

Statements of identification and general information of admissions, medical, social, financial status.
Past medical history.
Facts concerned with Obstetric patients only.
Facts concerned with Gynecologic patients only.
All other medical conditions.
Hospital routines, tests, and operating room procedures and results.
Morbidity and blood pressure.
Type of patient.
Results.

This arrangement has proved helpful in writing, in punching and in reading the summary sheets. The use of the summary sheet is not at all limited to the punched card system. It is considered valuable by the doctors as a summary of the history for reference in subsequent visits of the patient.

With the summaries accurately and conveniently checked, it is a simple matter for the record librarian to punch the cards in the record library. (See Fig. 171). The cards may be sorted when desirable, which we find advisable at monthly intervals.

The allocations are typed in tabulation form by month and year according to column and code and filed in the record library. At the end of the year these tables will be bound. The volume will be annotated and interpreted by the writer. From looking at these tables, correlations appear, indications for investigations are noted and certain trends in procedures are evident. (See Fig. 172.)

1933 - 1934

	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
Column 19 Pelves													
0 Normal pelvis — include justo-major as normal	208	189	174	200	156	182	201	206	198	185			
1 Contracted pelvis — congenital type	39	17	22	30	24	16	20	20	26	20			
2 Contracted pelvis — acquired type	13	4	10	13	12	7	3	4	0	0			
3 Contracted pelvis — miscellaneous	0	1	0	0	0	0	2	1	1	1			
4 Pelvis — type not determined	0	0	0	0	0	0	1	0	2	0			
* Cards rejected	67	73	76	84	89	61	56	67	59	70			

* Not maternity cases.

	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
Column 32 Weight of Newborn at Birth													
0 Less than 1,000 grams	3	1	5	0	3	1	2	0	2	3			
1 1,000 to 1,500 grams	4	2	0	1	0	3	1	0	3	2			
2 1,501 to 2,000 grams	3	3	3	5	2	4	3	3	5	4			
3 2,001 to 2,500 grams	12	9	9	9	8	6	15	6	7	7			
4 2,501 to 3,500 grams	174	100	126	157	118	110	129	135	114	113			
5 3,501 to 4,500 grams	71	92	73	98	81	77	75	79	81	74			
6 4,501 to 5,000 grams	5	6	2	2	1	4	3	3	4	0			
7 5,001 or more grams	0	0	0	0	0	0	1	1	0	0			
* Cards rejected	56	71	66	74	75	61	54	70	68	73			

* No fetuses delivered.

	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
Column 44 Anomalies, Defects and Malformations, Etc.													
0 Vulva and vulvovaginal glands	0	0	0	0	0	0	2	1	0	1			
1 Urethra and bladder	0	1	0	0	0	0	0	0	0	0			
2 Vagina	1	0	0	0	1	0	1	0	0	0			
3 Perineum, anus and rectum	0	0	0	0	0	0	1	0	0	0			
4 Cervix uteri	0	0	0	0	2	0	1	3	5	1			
5 Corpus uteri and endometrium	0	0	0	0	1	0	1	0	1	0			
6 Fallopian tubes	0	0	0	0	0	0	0	1	0	0			
7 Ovaries	0	0	0	0	0	0	0	0	0	0			
8 Pelvis, miscellaneous, ligaments, etc.	0	0	0	0	0	0	0	0	0	1			
9 Breasts, nipples, etc.	0	0	0	0	0	0	0	0	0	0			
* Cards rejected	326	283	292	326	279	286	278	292	278	275			

* Anomalies, defects and malformations not present.

FIG. 172

Samples of tables prepared annually from punched cards

A letter-size file in the record library contains manila folders, labelled according to the columns of the summary sheet and, when necessary, subdivisions for each column are added. In each folder are two sets of history unit numbers which are the unit numbers of the histories indicated by the figure of that column in the book of tables. One set of these unit numbers is kept for per-

manent filing. The other set is enclosed in an envelope marked according to column and code. This set is used by the file clerks to pull histories upon request from doctors for various studies and analyses of types of cases and conditions.

Many requests for a study of the histories are received and the results of correlations and research, as they are added to the files, will constantly increase the value of the material in the punch card system. *In other words, this constitutes a system of cumulative data which increases with use and time. The more it is used the greater is the cumulative value.*

APPENDIX TO PART VI

Applications in Medical Research and in Hospitals

CHAPTER II

The Adair System of Punched Card Indexing for Obstetrics and Gynecology

Code Book

CONTENTS

Column	
1 to 6	Unit numbers
7	Month of discharge
8 to 9	Year of discharge
10	Admittance (Obs. and Gyn.)
11 to 16	Age, race, class, condition, etc., on admission
17 to 18	Past history
19	Pelves
20	Toxemias
21 to 26	Labor, position, termination, etc.
27	Open
28 to 31	Primarily obstetric operations
32 to 35	Fetus and newborn
36	Perverted pregnancy
37 to 38	Menstruation, Menopause and Sterility
39 to 41	Malposition and relaxation
42 to 43	Miscellaneous disturbances
44	Anomalies, etc.
45 to 46	Malignancies
47 to 48	Neoplasms, benign
49 to 53	Primarily gynecologic operations
54 to 56	Peritoneal and pelvic infections and etiology
57	Lues and Tuberculosis
58	Venereal Disease
59	Breast
60	Cardiac system
61	Endocrine system
62 to 63	Gastro-Intestinal system
64 to 65	Nervous system
66	Orthopedic system
67	Respiratory system
68 to 69	Special Senses and Dermatological system
70	Urinary system
71	Vascular and Hematopoietic system
72	Miscellaneous diseases (not Obs. and Gyn.)
73 to 74	Complication Classifications (Obs. and Gyn.)
75	Special Therapy
76	Morbidity rates and blood pressures
77 to 78	Height, weight and body type
79	Autopsy, Glycosuria (non-diabetic), and Antenatal care
80	Treatment and Condition on Discharge

Directions for filling out the top of the summary sheet on Obstetric patients

Directions for filling out the top of the summary sheet on Gynecologic patients

Outline for Gynecologic operations

Outline for history of operative deliveries

Instructions for writing cesarean section histories

COLUMNS 1 to 6 UNIT NUMBER

Use the corresponding number in each corresponding digit.

COLUMN 7 MONTH OF DISCHARGE

Use for number of month of discharge, number in each digit corresponding to number of month.
O October X November Blank December

COLUMNS 8 to 9 YEAR OF DISCHARGE

Employing last two numbers in year ('09, '77, etc.), and using same number in corresponding digits.

COLUMN 10 ADMITTANCE (OBS. AND GYN.)

0 Registered first in Obs. and Gyn. O.P.D.—not referred by physician.
1 Registered in Obs. and Gyn. O.P.D.—referred from other Clinics of University of Chicago.
2 Registered first in Obs. and Gyn. O.P.D.—referred by outside physician.
3 Hospitalized in Obs. and Gyn. from Obs. and Gyn. O.P.D.
4 Hospitalized in Obs. and Gyn. by transfer from other service of University of Chicago Clinics.
5 Admitted directly to hospital from outside without O.P.D. visitation.
6 Previously hospitalized on this service (Obs. and Gyn.) for present condition (e.g., the same pregnancy or same tumor, infection, etc.).
7 Seen by our Obs. and Gyn. Department in Home Service O.P.D. or in Hospital for previous pregnancy (state whether Obs. or Gyn. this time).
8 Seen by our Obs. and Gyn. Department in Home Service O.P.D. or in Hospital for Gyn. state—not the same as this visit (state whether Obs. or Gyn. this time).
9 Open.

COLUMN 11 RACE AND ECONOMIC CLASSIFICATION

Note if mixed races, check accordingly.
0 Caucasian (all white races, including Latin races, Jews, Balkans, Russians, etc.).
1 Oriental (Chinese, Japanese, Korean, Tibetans, etc.).
2 Ethiopian (all negroes).
3 Indian (North and South American).
4 Other (Hindu, Eskimo, Persian, Arabian, Egyptian, Moroccoan, Turks, New Zealand and Australian Aborigines, Siamese, Philippines, Hawaiians, etc.).
5 W.P. Ward patients—paying ward rates.
6 P—S.P. Private and semi-private patients of Teaching Staff.
7 P—S.P. Private and semi-private of Courtesy Staff.
8 W.F. Free patients—patients paying nothing themselves for hospital or professional services (including those whose expenses are paid by charities and societies for indigents).
9 W.P.P. Part free patients—patients paying part of the hospital expense but nothing for professional service.

COLUMNS 12-13 AGE

Age of patient recorded by year of birth, using last two years, as '89, '97, '14, etc., and corresponding columns and numbers for corresponding digits and numbers.

COLUMN 14 SOCIAL STATE

0 Single (never married).
1 Married (at this time).
2 Widow (husband dead).
3 Divorced, legal separation, and undivorced but separated women.
4-9 Open

COLUMN 15 CONDITION AND TYPE OF PATIENT ON ADMISSION

0 Moribund, near death, grave.
1 Acute or emergency, but not moribund at or on admission.
*2 Obstetric—all patients having (or having had within 8 weeks) a product of conception, normal pregnancy, abortion, hydatidiform mole, ectopic pregnancy, etc. (*Check* 3, 4, 5 *and* 6, *as needed.*)
*3 Obstetric patient not in labor.
*4 Obstetric patient in labor.
*5 Obstetric patient—postpartum (when admitted for state or complication related to recent pregnancy up to 8 weeks after delivery—may be extended to 12 weeks if traceable to earlier date).
*6 Patient had delivery attempted elsewhere and brought in for completion of delivery.
7 Gynecologic (exclude abortion, ectopic pregnancy, hydatidiform mole, choriopithelioma).
8 Other types (not Obs. or Gyn.), as medical or surgical, boarders, malingers, etc.
9 Medical babies—babies brought in or brought back by mother but not delivered on this admission.

* Check 3, 4, 5, 6, after 2.

NOTE: Cases delivered on way to hospital record as postpartum and medical baby.

COLUMN 16 SPECIAL DATA RECORDED AS ON ADMISSION OR WHEN FIRST SEEN

0 Virgin (evidence indicating that a phallus or foreign body has not insulted the hymen).
1 Nulligravida (evidence revealing a marital outlet, but never pregnant).
2 Gravida (evidence of gestation existing or having existed, but not carried to viability).
3 Para (evidence suggesting that one or more viable fetuses have been born).
4 Undetermined (state of introitus and hymen, vulva and vagina not indicated).
5 Medico-legal (including all potential or court cases, as rape, pregnancy under age of consent, question of paternity, pregnancies in widows, divorcees, etc.).
6-9 Open.

COLUMN 17 PAST HISTORY ON ADMISSION

0 Patient has had (previously) abdominal operation(s) which was (were) not obstetric or gynecologic.
1 Patient has had (one or more) abdominal gynecologic operation(s).
2 Patient has had (one or more) vaginal gynecologic operation(s).
3 Patient has had (one or more) cesarean section(s).
4 Patient has had abdominal obstetric operation other than cesarean section, as No. 3.
5 Patient has had forcep(s), version(s), and/or extraction(s) of fetus(es).
6 Patient has had vaginal obstetric operation (other than No. 5), such as episiotomies, Duhrssen's, etc.
7 Patient has had destructive operation(s) and/or still-born baby(ies).
8 Patient has had treatment for infertility or sterility (all such cases receiving any such treatment, help, etc.).
9 Patient has received previously X-ray and/or radium therapy.

COLUMN 18 PAST HISTORY CONTINUED

*0 Patient has had (one or more) intentional abortion(s).
1 Patient has had (one or more) unintentional abortion(s).
2 Patient has had puerperal or post-abortal sepsis.
3 Patient has had hemorrhage and/or shock in previous Obs. or Gyn. episode (exclude abruptio placentæ and placenta prævia).
4 Patient has had placenta prævia and/or abruptio placentæ.
5 Patient has had one or more toxemias (exclude hyperemesis) of pregnancy or known to have nephritis or nephrosis without pregnancy.
6 Patient has had hyperemesis gravidarum (the pathologic state and not

the more common type of vomiting in pregnancy).
7 Patient has had vulval pruritis, particularly in previous pregnancy.
8 Patient has had previously one or more gynecologic conditions.
9 Miscellaneous for such as breast abscess, etc.

* Abortion means termination before the 22nd week of gestation, or a fetus less than 28 cm. long and weighing less than 400 gms.

COLUMN 19 PELVES

DETAILS FOR CLASSIFYING PELVES

COLUMN 19

	NORMAL	SIMPLE FLAT	TRANSVERSE FUNNEL	G. C. OR JUSTO-MINOR	RACHITIC FLAT (RICKETS) G. C. (Must have osseous evidence of rickets)	
Inter-spines	25-28	Unchanged	Unchanged	Decreased	Ratio altered	Ratio altered Decreased
Inter-crests	25-31	Unchanged	Unchanged	Decreased	2-4 cm. normal	Decreased
Inter-troch.	30-33	Unchanged	Unchanged	Decreased		
Ext. conj.	18-21	Probably 18 or less	Unchanged	Decreased	Decreased	Decreased
Rt.	21½					
Ext. obl. Lt.	22					
C. D.	11.5	11 or less	Unchanged	11.5 or less	11 or less	11.5 or less
C. V.	9.5					
Bi-isch.	9-11	Unchanged	8 or less	8 or less	Increased	Increased
Post-sag.	7.5-9	Unchanged	May be increased	Decreased		
Ant.-Post.	9.5-11	Unchanged	May be increased	Decreased		

ant.-post. funnel

Other types as Naegle, Roberts, osteomalacia, etc., diagnosed by usual standards.

See chart above for details for classifying pelves.

0 Normal — include justo-major as normal.
1 Contracted—congenital
- A. Flat
- B. Funnel } or combination
- C. Masculine }
- D. Generally contracted—justo-minor
- E. Naegle
- F. Roberts
- G. Assimilation

2 Contracted—acquired (resulting from disease or injury)
- A. Rachitic
  - (a) Typical
  - (b) Flat
  - (c) Generally contracted
- B. Osteomalacic
- C. Fractured pelvis
- D. Spinal changes
  - (a) Spondylolisthesis
  - (b) Kyphosis
  - (c) Scoliosis
  - (d) Lordosis
  - (e) Posture
- E. Lameness
  - (a) Unilateral
  - (b) Bilateral

3 Contracted—miscellaneous
- A. Endocrinal pelves
- B. Dwarfism, etc.

4 Pelves—undetermined (not classified above).
5-9 Open.

COLUMN 20 TOXEMIAS

0 *Essential hypertension*
A persistent elevation of blood pressure of 140 mm. or more, without any other signs or symptoms of toxemia, nephritis, or arteriosclerosis.

1 *Nephritis*
History of nephritis. The occurrence of hypertension, edema, albuminuria, abnormal number of formed elements in the urine sediment, a persistent impairment of kidney function, history of repeated abortions or premature labor, with a negative Wassermann, and/or marked infarction of the placenta are indicative of a nephritis.

2 *Nephrosis*
The occurrence of edema, albuminuria, normal number of formed elements, normal kidney function and no hypertension, together with low serum proteins and a cholesterolemia.

3 *Pre-eclampsia*
The sudden occurrence of hypertension above 130 (repeated determination), edema, albuminuria, normal kidney function, with or without headache, visual disturbances, epigastric pain, vomiting, abnormal weight gain, diminution of urinary output.

4 *Eclampsia*
Idem, associated with either convulsions or coma or both.

5 *Hyperemesis gravidarum*
The occurence of nausea and/or vomiting to a degree sufficient to cause: A loss of weight of 5 per cent or more, a persistent pulse rate of 120 or more, neuritis, jaundice, hematuria.

6 *Miscellaneous*
Acute yellow atrophy, jaundice of unknown origin, nervous disorders of unexplained origin, neuritis.

7-9 Open.

COLUMN 21 LABOR

0 Spontaneous onset, without aid, as defined in 3 and 5 below.
1 False labor.
2 Drug induction of labor attempted (all types by drugs).
3 Drug induction of labor failed (no onset within 24 hours).
4 Mechanical induction of labor attempted (bag, bougie, stripping membranes, rupture of membranes, packing, etc.).
5 Mechanical induction failed (no onset within 24 hours).
6 Short labor
Primipara less than 10 hours
Multipara less than 5 hours
7 Average labor
Primipara 10 to 24 hours
Multipara 5 to 20 hours
8 Long labor
Primipara over 24 hours
Multipara over 20 hours
9 Open.

COLUMN 22 LABOR CONTINUED

0 Termination—spontaneous (without aid other than outlet maneuver—exclude breeches and outlet forceps, etc.).
1 Artificial (operative or manual aid, as extraction, version, etc.).
2 Blood loss—small (less than 100 c.c.—estimated, not measured).
3 Blood loss—moderate (100 to 500 c.c.—estimated, not measured).
4 Blood loss—excessive (over 500 c.c.—estimated, not measured).
5 Blood loss—small (less than 100 c.c.—measured).
6 Blood loss—moderate (100 to 500 c.c.—measured).
7 Blood loss—excessive (over 500 c.c.—measured).
8 Antepartum genital bleeding due to causes not specified where patient was seen or examined to determine cause of bleeding.
9 Manual exploration of uterus.

COLUMN 23 MEMBRANES

0 Rupture—spontaneous, unintentional, or accidental.
1 Intentional rupture by artificial means.
2 Premature rupture—before onset of labor.
3 Early rupture—after onset of labor but before 6 cm. dilatation.
4 Usual rupture—after 6 cm. to beginning of second stage (complete dilatation).
5 Delayed rupture—remaining intact after onset of second stage.
6-9 Open.

COLUMN 24 INLET PRESENTATION AND POSITION*

0 Occiput
1 Other cephalic (face, brow, etc.)
2 Breech
3 Transverse (scapula)
4 Right—side
5 Left
6 Anterior
7 Transverse
8 Posterior
9 Miscellaneous

* Punch one of:
0, 1, 2, or 3, 4 or 5 (except where a direct anterior or posterior),
6, 7, or 8, Unless 9.

COLUMN 25 OUTLET PRESENTATION AND POSITION*

0 Occiput
1 Other cephalic (face, brow, etc.)
2 Breech
3 Cross (scapula)
4 Right
5 Left
6 Anterior
7 Transverse
8 Posterior
9 Miscellaneous

* Punch one of:
0, 1, 2, or 3, 4 or 5 (except where a direct anterior or posterior),
6, 7, or 8 Unless 9.

COLUMN 26 PLACENTA, CORD, AND AMNIOTIC FLUID

0 Placenta—abnormal (excessive size, weight more than one-fourth of weight of baby, placentitis, lues, etc., small—less than one-eighth of weight of baby).
1 Placenta—abnormal site, prævia, etc.
2 Abruptio placentæ and premature separation.
3 Other abnormal placentæ, as adherent, extra lobes, multiple deformities, etc.
4 Cord entanglement about fetus.
5 Cord prolapse—occult and other.
6 Cord—miscellaneous (abnormal length over 75 or less than 25 cm.), knots, ruptures, etc.
7 Amniotic fluid—normal amount (100 to 750 c.c.).
8 Amniotic fluid—excessive amount (polyhydramnios—more than 750 c.c.).
9 Amniotic fluid—miscellaneous. Oligohydramnios—(less than 100 c.c.).

COLUMN 27 SPACE RESERVED FOR EXPANSION OF CODE

COLUMN 28 OPERATIONS—PRIMARILY OBSTETRIC

0 Episiotomy and perineotomy—repair (record only when episiotomy is repaired or when perineum has incision and plastic repair—see Column 41, No. 0 for unrepaired episiotomy).

1 Duhrssen's incision—incision of cervix to aid in dilatation of cervix (by vaginal route).
2 Manual removal of placenta—for manual removal of part or of all of placenta (limited to premature, term, and excessive sized fetuses).
3 Uterine tamponade—uterine packs, etc.
4 Low and/or prophylactic forceps (lowest portion of presenting part must be at or on pelvic floor at beginning of operation).
5 Mid forceps (when presenting part is above pelvic floor, but greatest diameter of head is through or at inlet at beginning of operation).
6 High forceps and floating forceps (when greatest diameter is definitely above inlet of pelvis at beginning of operation).
7 Manual rotation of fetal head from a posterior position to transverse or anterior variety. This does not include rotations from the transverse or anterior positions to anterior place.
8 Forceps rotations—from posterior position to transverse or anterior variety. Does not include rotation from transverse or anterior position.
9 Forceps on aftercoming head—application of forceps made on the aftercoming head.

COLUMN 29 OPERATIONS CONTINUED

0 Version without extraction—Braxton-Hicks, converting to a breech but without extraction.
1 Version and extraction—extraction of fetus after version.
2 Cephalic version—converting position from another to a head presentation.
3 Conversion—changing the presenting pole by flexion, extension, pronation and/or rotation to another part, as face to occiput, etc. (exclude rotation of occiput from one to another positions).
4 Breech extraction—when breech occurs without external or internal version, but receives aid in the delivery.
5 Destructive operations—include craniotomy, evisceration, gross amputations and decapitations, etc.
6 Hysterotomy—incising and closing uterus, especially for producing abortion abdominally (exclude cesarean sections and vaginal hysterotomy), prior to fetal viability.
7 Laparotrachelotomy and atypical sections—include low cervical or low segment cesarean section.
8 Classic sections—all other general types—includes porro.*
9 Vaginal cesarean section—vaginal hysterotomy.
* (All other operations punch under gynecology—i.e., for porro, punch classic c.s. and also subtotal hysterectomy).

COLUMN 30 SPACE RESERVED FOR EXPANSION OF CODE

COLUMN 31 TIME OF OBSTETRIC OPERATION

0 Before onset of labor.
1 During first stage.
2 During second stage. (Episiotomy repair—check in postpartum.)
3 During third stage.
4 During postpartum period. (Episiotomy repair—here.)
5-9 Open.

COLUMN 32 WEIGHT OF NEWBORN AT BIRTH

0 Less than 1,000 grams
1 1,001 to 1,500 grams
2 1,501 to 2,000 grams
3 2,001 to 2,500 grams
4 2,501 to 3,500 grams
5 3,501 to 4,500 grams
6 4,501 to 5,000 grams
7 5,001 or more grams
8-9 Open.

COLUMN 33 FETUS AND NEWBORN—VIABILITY

*0 Abortion
   1. Less than 28 cm. long.
   2. Less than 400 gm. in weight.
   3. Less than 22 weeks (missed abortions are excluded).
*1 Premature
   1. From 28 to 47 cm. long.
   2. From 400 to 2,499 gm. in weight.
   3. From 22nd to end of 37th week of gestation.
*2 Term
   1. From 47 (+) cm. to 54 (—) cm. long.
   2. From 2,500 to 4,499 gm. in weight.
   3. From 38th to end of 43rd week.
*3 Excessive size (post-mature).
   1. More than 54 (+) cm. long.
   2. More than 4,500 gm. in weight.
   3. More than 43 weeks.
4 Antenatal death = death before onset of labor.
5 Intranatal death = death during labor.
6 Postnatal death = showing signs of life at birth but not being resuscitated (breathing).
7 Neonatal death = living at birth but dying before discharge from hospital (do not confuse with postnatal death).
8 Living birth.
9 Autopsy on fetus or newborn.
* Given in order of importance, any two of which will make diagnosis permissible.

COLUMN 34 FETUS AND NEWBORN—DISEASES

0 Suffocation, aspiration, etc. (Include prolapsed cord, separation of placenta, knotted cord, rupture of cord, premature inspiration, etc.)
1 Trauma—major (include intracranial hemorrhage, brain, cord and major nerve injury, serious fractures, etc.).
2 Trauma—minor (include minor abrasions, caput succedaneum, etc.).
3 Infection—congenital (lues and others which are present before onset of labor and before interference).
4 Infection—other major (gonorrhea of eyes, rectum, etc., pemphigus, impetigo, thrush, etc.).
5 Infection—minor (slight or less serious, as heat rash, non-specific conjunctivitis, etc.).
6 Prematurity and/or immaturity.
7 Congenital state—major (spina bifida, hydrocephalus, anencephalus, abdominal and thoracic defects, grave or incompatible (with life) anomalies and defects (gastro-intestinal, etc.), kidney diseases, etc., hare lip, cleft palate).
8 Congenital state—minor (supernumerary digits, club foot).
9 Miscellaneous and icterus neonatorum (only grave type).

COLUMN 35 SEX, FEEDINGS, AND DISCHARGE STATE OF NEWBORN

0 Sex—male (for single pregnancy).
1 Sex—female (for single pregnancy).
2 Sex—male (for multiple pregnancy)—if two or more male children, check 0 and 2.
3 Sex—female (for multiple pregnancy—if two or more female children, check 1 and 3).
4 Feeding—breast only.
5 Feeding—artificial only.
6 Feeding—combination of breast and artificial.
7 Discharged—alive and satisfactorily.
8 Discharged—alive but unsatisfactorily or transferred to other service.
9 Circumcised before leaving hospital.

COLUMN 36 PERVERTED PREGNANCY

Abortion includes gestation termination with length less than 28 cm., wt. less than 400 gms., or less than 22 weeks (any two will establish).

*0 Abortion—complete (the product of conception passed or removed completely before admission).
1 Abortion—threatened (include inevitable, imminent, etc.).
2 Abortion—incomplete of first trimester, retained secundines.
3 Abortion—incomplete of second trimester, retained secundines.
4 Abortion—intentional—done for therapeutic reasons.
5 Abortion—intentional—done merely to terminate gestation and without legal reason, whether done by patient or an abortionist.
6 Abortion—unintentional—occurring without an introductory stimulation.
7 Abortion—missed (fetus died in previable periods, but not expelled or removed until some time later).
8 Ectopic—any gestation not within the uterine cavity, whether intact or ruptured, dead or living.
9 Hydatidiform mole and/or chorioepithelioma.
* Check 1, 2, 3, 4, 5, 6, and/or 7 also as needed with 0.

COLUMN 37 MENSTRUATION

0 Abnormal onset—catamenia (delayed or precocious under 11 and over 16 years).
1 Hypomenorrhea—scanty menstruation (record if no organic cause found).
2 Hypermenorrhea (menorrhagia)—record if no organic cause found.
3 Polymenorrhea, metrorrhagia (record if no organic cause found).
4 Amenorrhea (record if no organic cause found).
5 Irregular menstruation (record if no organic cause found).
6 Vicarious menstruation.
7 Dysmenorrhea (painful periods—whether local or generalized).
8-9 Open.

COLUMN 38 STERILITY AND MENOPAUSE

0 Sterility in male (include if any factors predisposing to infertility).
1 Sterility in female (include if any factors predisposing to infertility). Check 2, 3 or 4.
2 Sterility in female (tubal).
3 Sterility in female—other (except endocrine).
4 Sterility in female—endocrinal.
5
6 Menopause—physiological.
7 Menopause—artificial.
8 Menopause—abnormal (as premature, delayed); (delayed over 50 years).
9 Post-menopausal bleeding (only when no organic cause is found).

COLUMN 39 MALPOSITION OF UTERUS AND ADNEXA

0 First and second degree retroversion
First degree—fundus of uterus between normal, anterior and promontory of sacrum.
Second degree—fundus of uterus from promontory to body of third sacral vertebra.
1 Third degree retroversion—fundus of uterus below third sacral vertebra.
2 Postpartum retroversion—occurring within 6 to 12 weeks after delivery.
3 Adherent retroversion (include fixed, immovable and incarcerated uteri).
4 Symptoms produced by retroversion (other factors must be eliminated first).
5 Prolapse
First degree—from normal position until cervix gets to introitus.
Second degree—cervix protrudes through but corpus is not outside introitus.
6 Prolapse
Third degree—corpus outside introitus.
7 Inversion of uterus—all types.
8 Other malpositions of uterus (lateral, etc., retroversion).
9 Abnormal displacement of adnexa (when not associated with retroversion and prolapse of uterus).

COLUMN 40 LACERATION AND RELAXATION

0 Cystocele (all degrees—anterior colpocele).
1 Rectocele (all degrees—posterior colpocele).
2 Urethrocele, urethral caruncle, and urethral prolapse.
3 Enterocele and/or vaginal hernia.
4 Fistula—all kinds—invading the reproductive or genital tract.
5 Eversion, ectropion of cervix.
6 Erosion of cervix.
7-9 Open.

COLUMN 41 LACERATION CONTINUED

0 Episiotomy unrepaired (made but not repaired).
1 Perineal lacerations—first and second degree—recent.
First degree—skin and mucosa but no muscle—with this delivery.
Second degree—from muscle to sphincter and/or rectum.
2 Perineal lacerations—first and second degree—old.
3 Perineal laceration—third degree or complete—recent (involves sphincter and/or rectum—with this delivery).
4 Perineal laceration—third degree or complete—old.
5 Vaginal laceration—recent (excluding perineal injury).
6 Vaginal laceration—old (excluding perineal injury).
7 Cervical laceration—recent—with this delivery.
8 Cervical laceration—old.
9 Uterine laceration or rupture—all kinds.

COLUMN 42 MISCELLANEOUS DISTURBANCES

0 Fibrosis uteri.
1 Subinvolution of the uterus (Obs. and Gyn.).
2 Hyperplasia endometrium—simple.
3 Polyps and polyposis—benign neoplasm of endometrium.
4 Kraurosis vulvæ.
5 Senile atrophy—of female genital organs.
6 Foreign body in generative tract or pelvis.
7 Return case—*new* diagnosis made.
8
9 Gyn. and/or Obst. states absent.
No Gyn. or Obst. diagnosis.
Normal pelvis.

COLUMN 43 MISCELLANEOUS DISTURBANCES

0 to 3, open.
4 Pruritis vulvæ—etiology unknown.
5
6 Hematometra and lochiometra.
7 Hematoma—in Gyn. patient.
8 Hematoma—in Obs. patient.
9 Miscellaneous.

COLUMN 44 ANOMALIES, DEFECTS AND MALFORMATIONS, ETC.

0 Vulva and vulvovaginal glands.
1 Urethra and bladder.
2 Vagina.
3 Perineum, anus and rectum.
4 Cervix uteri (include stenosis of cervix).
5 Corpus uteri and endometrium.
6 Fallopian tubes.
7 Ovaries.
8 Pelvis, miscellaneous, ligaments, etc.
9 Breasts, nipples, etc.

COLUMN 45 MALIGNANCY—CARCINOMA OF—PUNCH PRIMARY SITE ONLY

0 Vulva and vulvovaginal glands.
1 Urethra and bladder.
2 Vagina.
3 Perineum, anus and rectum.
4 Cervix uteri.
5 Corpus uteri and endometrium.
6 Fallopian tubes.
7 Ovaries.
8 Pelvis, miscellaneous, ligaments, etc.
9 Breasts, nipples, etc.

COLUMN 46 MALIGNANCY—SARCOMA OF—PUNCH PRIMARY SITE ONLY

0 Vulva and vulvovaginal glands.
1 Urethra and bladder.
2 Vagina.
3 Perineum, anus and rectum.
4 Cervix uteri.
5 Corpus uteri and endometrium.
6 Fallopian tubes.
7 Ovaries.
8 Pelvis, miscellaneous, ligaments, etc.
9 Breasts, nipples, etc.

COLUMN 47 BENIGN NEOPLASM OF

0 Vulva and vulvovaginal glands.
1 Urethra and bladder.
2 Vagina.
3 Perineum, anus and rectum.
4 Cervix uteri.
5 Corpus uteri (endometrial benign neoplasms in Col. 42, No. 3).
6 Fallopian tubes.
7 Ovaries.
8 Pelvis, miscellaneous, ligaments, etc.
9 Breasts, nipples, etc.

COLUMN 48 OTHER PATHOLOGIC STATES

0 Endometriosis.
1 Multiple small cysts of ovary.
2 Teratoma—solid.
3 Teratoma—cystic.
4 Metastatic tumors.
5 Rare ovarian tumors (unclassified), granulosa, etc.
6-9 Open.

COLUMN 49 OPERATIONS (31-35 inclusive, primarily gynecologic)

0 Examination under anesthesia—used only in absence of other procedures.
1 Operation upon Bartholin's glands, clitoris, and hymen (except biopsy).
2 All other vulval operations (except biopsy).
3 Dilatation of cervix and/or curettage of cervical canal and/or uterus.
4 All cauteries on cervix (chemical, electrical, therapeutic or destructive).
5 Biopsy on any pelvic organ.
6 Removal of polyp of cervix, uterus, vagina, or vulva.
7 Insertion of any type of pessary.
8 Removal of foreign body from any pelvic organ (exclude pessary if a therapeutic procedure).
9 Rubin's test and/or visualization study of reproductive tract.

COLUMN 50 OPERATIONS CONTINUED

0 Anterior vaginal plastic and repair, as cystocele, urethrocele (exclude fistula repair and interposition operation, biopsy).
1 Posterior vaginal plastic—rectocele, enterocele, and repair of perineal and anal sphincter lacerations (exclude biopsy).
2 Other vaginal operations—occlusion, reconstruction, etc. (exclude biopsy, pessary insertion, vaginal hysterectomy, interposition operation, etc.).
3 Urethral operations.
4 Any and all fistulæ repairs or operations directed toward such.
5 Cervical plastic—repairs and reconstructions, etc.
6 Cervical amputation and other operations.
7 Hemorrhoidectomy—when done on this service.
8 Drainage operation (abdominal or vaginal) of abscesses, hematomas, etc. (exclude breast).
9 Breast abscess drainage.

COLUMN 51 OPERATIONS CONTINUED

0 Hysterectomy—subtotal or supravaginal—removal of the body of the uterus without the cervix, tubes or ovaries (Check 2 or 3).
1 Hysterectomy—total—removal of cervix and body of uterus, but without tubes or ovaries (Check 2 or 3).
2 0 or 1—by abdominal route.
3 0 or 1—by vaginal route.
4 Salpingectomy—unilateral (only one tube removed).
5 Salpingectomy—bilateral (both tubes removed).
6 Salpingostomy—operation upon tube (not for removal or for sterilization—sterilization in Column 53, No. 9).
7 Oophorectomy—unilateral (removal of all of one ovary).
8 Oophorectomy—bilateral (removal of both ovaries in toto).
9 Oophorectomy—partial (removal of part of one or of each ovary).

COLUMN 52 OPERATIONS CONTINUED

0 Uterine suspension—operation for support of the operation (exclude interposition) includes suspension, fixations and shortening of ligaments.
1 Myomectomy—removal of fibroid nodules from the body of uterus.
2 Removal of other abdominal newgrowths by abdominal or vaginal route.
3 Exploratory laparotomy—operation within abdomen, for explorations, diagnosis, and treatment of obscure preoperative diagnosis, or for conditions not otherwise covered.
4 Interposition—transposition of uterus.
5 Appendectomy—all types.
6 Herniotomy—any type repaired in connection with Obs. and Gyn. work.
7 Viscus repair—repair of injury or defect of any viscus or viscera not included above, as bladder, urethra, bowel, etc., blood vessels, etc.
8 Wertheim and other radical operations.
9 Radium and radon therapy—application in any form.

COLUMN 53 OPERATIONS CONTINUED

0 to 4, open.
5 Separation of abdominal adhesions.
6 Bladder visualization.
7 Amniography.
8 Ovarian transplant—any and all types.
9 Intentional sterilization—any procedure directed at such, whether by ligation of tubes, cautery of horns, resections, X-ray or radium, or sensitizations, etc.

COLUMN 54 INFECTION

0 Pelvic peritonitis.
1 General (abdominal) peritonitis.
2 Ileus (paralytic)—ileus due to infection recorded under 0 or 1.
3 Pelvic adhesions—regardless of cause.
4 Pelvic abscess—whether single or multiple.

5 Abdominal wound—infected or defective healing process.
6 Perineal and vaginal wounds—infected or defective healing process.
7 Cervical wound—infected or defective healing process.
*8 Septicemia and bacteriemia.
9 Eventration.

* Puerperal septicemia is an infection arising from or localizing in the female genitalia in association with pregnancy, its termination, or the puerperium and producing the systemic symptoms and findings of sepsis (infection).

COLUMN 55 INFECTION

0 Vulvitis and vaginitis—all types.
1 Bartholinitis, skenitis—all types.
2 Urethritis—all types.
3 Cystitis—all types.
4 Rectal and anal infections—all types.
5 Cervicitis and endocervicitis—all types.
6 Endometritis, metritis—all types.
7 Salpingitis, salpingo-oophoritis, and oophoritis—all types.
8 Peri- and parametritis, with adnexitis—also cellulitis.
9 Residual pelvic inflammation, particularly old.

COLUMN 56 ETIOLOGY OF INFECTION

0 Fungous—all types of fungi.
1 Protozoan—all types of protozoa.
2 Gonococcic—acute.
3 Gonococcic—chronic.
4 Pyogenic—acute (all bacteria not in 2, 3, 6, 7 and 8).
5 Pyogenic—chronic (all bacteria not in 2, 3, 6, 7 and 8).
6 Lues—all types.
7 Tuberculosis—all types.
8 Other granulomas and venereal not elsewhere checked.
9 Open.

COLUMN 57 LUES AND TUBERCULOSIS

0 Lues—primary, genital or otherwise.
1 Lues—secondary.
2 Lues—latent—four plus blood Wassermann and without symptoms.
3 Lues—cerebro-spinal, congenital lues, and other.
4 Open.
5 Tuberculosis—pulmonary.
6 Tuberculosis—urinary.
7 Tuberculosis—genital.
8 Tuberculosis—lymph glands.
9 Tuberculosis—gastro-intestinal and other structures.

COLUMN 58 VENEREAL DISEASE

Venereal Includes Gonorrhea, Syphilis, Chancroid, Granuloma Inguinale, Lymphogranuloma, etc.

0 Gonorrhea—genital.
1 Gonorrhea—extra-genital.
2 Other venereal—genital.
3 Other venereal—extra-genital.
4-9 Open.

COLUMN 59 BREAST

0 to 4, open.
5 Cracked nipples—all degrees.
6 Non-inflammatory congestion of breast.
7 Inflammation without suppuration.
8 Inflammation with suppuration.
9 Breast conditions not diagnosed elsewhere.

COLUMN 60 CARDIAC SYSTEM

If more than one involved, check accordingly.
0 Pericarditis—all types.
1 Endocarditis—all types.
2 Myocardial changes, degeneration, etc.
3 Valvular disease—all types.
4 Fibrillation—all degrees.
5 Acute dilatation.
6 Decompensation present—all degrees.
7 Coronary disease—all types.
8 Congenital heart states.
9 Miscellaneous.

COLUMN 61 ENDOCRINAL DISEASES

If more than one involved, record accordingly.
0 Diabetes mellitus.
1 Hypothyroidism.
2 Hyperthyroidism and dysthyroidism.
3 Hypopituitarism and infantilism.
4 Hyperpituitarism, acromegaly and gigantism.
5 Dyspituitarism—Fröhlich's syndrome.
6 Obesity.
7 Open.
8 Addison's disease and other suprarenal diseases.
9 Miscellaneous diseases of parathyroid, thymus, etc.

COLUMN 62 GASTRO-INTESTINAL TRACT (ESOPHAGUS, STOMACH, INTESTINES)

If more than one involved, record as such.
0 Infection of gastro-intestinal tract or portion of it.
1 Ulcer—upper gastro-intestinal tract.
2 Constipation—all degrees.
3 Obstruction—all types.
4 Appendicitis.
5 Parasites, as worms, etc.
6 Colitis—all types, except specific, such as typhoid, etc.
7 Rectal or anal disease—exclusive of hemorrhoids (see Col. 71, No. 2).
8 Dysentery diseases—not elsewhere diagnosed.
9 Miscellaneous.

COLUMN 63 GASTRO-INTESTINAL GLANDS

All glands except pituitary—derived in part or all from gastro-intestinal tract—if more than one involved, record as such.
0 Cholecystitis—acute.
1 Cholecystitis—chronic.
2 Cholelithiasis.
3 Cholangitis.
4 Hepatitis.
5 Hepatic abscess.
6 Retrogressive change in liver—cirrhosis, atrophy, etc.
7 Pancreatitis—all other states except diabetes mellitus.
8 Spleen—all diseases.
9 Miscellaneous for gastro-intestinal gland—parotitis (not epidemic), etc.

COLUMN 64 NERVOUS SYSTEM

0 Brain—disease due to circulatory disturbances, as hemorrhage, ischemia, infarction, thrombosis, etc. (excluding lues).
1 Brain—infections (encephalitis, abscess, etc.), old and recent.
2 Brain—other diseases as tumor, trophic disturbances, hydrocephalus, micro- and macrocephalus.
3 Cord—infections (all types and degrees of kind), excluding lues, poliomyelitis, etc.
4 Cord—injuries (traumatic, chemical, metabolic, etc.).

5 Cord—other states.
6 Meninges—infections and all other states.
7 Nerves—peripheral and cranial (infection, trauma, neuritis, etc.).
8 Nerves—other states (neuralgia).
9 Miscellaneous.

COLUMN 65 NERVOUS SYSTEM

0 Epilepsy—all types.
1 Chorea—all types.
2 Psychopathic tendencies and personalities, abnormal worry, neurosis, mental exhaustion, psychoneurosis.
3 Psychopathic tendencies and personalities, sexual references, masturbation, phantom tumors, pseudocyesis, vaginismus, excesses, frigidity.
4 Psychoses—all types.
5 Mental deficiencies—moron, imbecile, feebleminded, etc.
6 Headaches—of migraine origin.
7 Headaches—other than migraine—functional only (exclude those due to organic states).
8 Sleep disturbances, insomnia, somnabulism.
9 Miscellaneous (diagnose convulsions under cause). All convulsions not due to eclampsia.

COLUMN 66 ORTHOPEDIC

0 Sacro-iliac disease.
1 Sacro-coccygeal diseases—including sacro-sciatica.
2 Backache—due to cause other than reproductive system.
3 Lumbo-sacral disease.
4 Open.
5 Arthritis—all degrees and types.
6 Separation of symphysis.
7 Fractures (not pelvic)—old and recent.
8 Fractures (pelvic)—old and recent.
9 Miscellaneous.

COLUMN 67 RESPIRATORY SYSTEM*

0 Simple upper respiratory disease—rhinitis, laryngitis, nasopharyngitis.
1 Bronchitis—all types.
2 Broncho-pneumonia—all types.
3 Lobar pneumonia—all types.
4 Influenza—all types.
5 Embolism and infarction—all degrees.
6 Pleurisy—all degrees without effusion.
7 Pleurisy—all degrees with effusion. (If later absorbed record as with effusion).
8 Empyema.
9 Miscellaneous—abscess.
* (See Col 72 for sensitization).

COLUMN 68 SPECIAL DISEASES

0 Eye—infections.
1 Eye—vascular change.
2 Eye—errors of accommodation and refractions.
3 Other eye conditions.
4 Ear—infections.
5 Ear—other conditions.
6 Sinuses—all states (exclude mastoid).
7 Mastoids—all states.
8 Nose—all conditions (exclude sinuses).
9 Miscellaneous.

COLUMN 69 SPECIAL SENSES AND DERMATOLOGICAL SYSTEM

0 Throat infections—tonsillitis, pharyngitis, abscess, etc.
1 Throat—other conditions (enlarged tonsils, etc.)

2 Mouth, etc.—teeth, dental caries, newgrowths, etc.
3 Mouth—infections, etc.—miscellaneous.
4 to 7, open.
8 Dermatitis (infection, toxic, etc.).
9 Dermatoses—all types—neoplastic, physical, etc.

COLUMN 70 URINARY SYSTEM

If more than one concerned, record as such.
0 Pyelitis—pre-delivery and pre-operative.
1 Pyelitis—postpartum and post-operative.
2 Perinephritic abscess.
3 Pyelonephritis.
4 Hydronephrosis.
5 Hematuria—organic cause not found.
6 Stricture—any place in urinary tract.
7 Calculi—any place in urinary tract.
8 Open.
9 Miscellaneous.

COLUMN 71 VASCULAR SYSTEM AND HEMATOPOIETIC SYSTEM AND LYMPHATICS

0 Varicosities—genital.
1 Varicosities—extremities.
2 Varicosities—other (including hemorrhoids).
3 Thrombosis and thrombophlebitis.
4 Miscellaneous—all other vascular diseases (including lymphatics not elsewhere noted).
*5 Anemia—secondary (pre-operative, antepartum).
*6 Anemia—secondary (post-operative, postpartum).
*7 Anemia—due to hemorrhage.
8 Primary anemia.
9 Miscellaneous blood diseases—leukemia, Hodgkin's, purpura, etc.

* Secondary anemia—10 grams or less—hemoglobin, or 59.2% or less Newcomer or Williamson, or 72.4% or less Palmer. Hematocrit 30.1 or less. R.B.C. 3,150,000 or less.

COLUMN 72 MISCELLANEOUS

0 Acute infectious diseases—mumps, measles, whooping cough, chicken pox, small pox, scarlet fever, etc.
1 Other general infectious diseases, as typhoid, para-typhoid, etc.
2 Other general non-infectious diseases—vitamin deficiencies, metabolic diseases, etc.
3 Hernia—post-operative, abdominal or vaginal.
4 Hernia—other.
5 Malnutrition and inanition.
6 Drug poisoning—all kinds (intentional or accidental).
7 Burns—chemical, thermal, mechanical, electrical, etc.
8 Sensitization—asthma.
9 Sensitization—other.

COLUMN 73 COMPLICATION

0 Obstetrical and/or gynecological—patient without complications.
1 Infection—genital.
2 Infection—extra-genital.
3-9 Open.

COLUMN 74 ANESTHESIA, ANALGESIA FOR ALL OBS. AND GYN. OPERATIONS AND ANESTHESIA COMPLICATIONS

0 Analgesia—medications to relieve pain of labor or operations, as opiates, barbiturates, etc., combined as morphine, scopolamine.
1 General anesthesia—ether (when ether only is used).
2 General anesthesia—ethylene (when only ethylene is employed).

3 Combined anesthesia—ether and ethylene.
4 Nerve block (include local, spinal, caudal, sacral, perineal, etc.)
5 Orificial and hypodermic, as by mouth, per rectum, intravenous, intramuscular—all types.
6 Miscellaneous anesthesia—all others (as nitrous oxide, chloroform, and any others not accounted for.
7 Open.
8 Anesthesia complications, as anesthesia pneumonia, aspiration pneumonia, etc.
9 Anesthesia accidents—anesthesia over-dosage, explosives, etc.

COLUMN 75 SPECIAL THERAPY

0 Blood transfusion.
1 Other intravenous (glucose, etc.).
2 Subcutaneous, as saline, glucose, etc.
3 Vaccine, filtrate, antitoxin, etc.
4 Hormonal.
5-8 Open.
9 Hormonal test.

COLUMN 76 FEMALE MORBIDITY AND BLOOD PRESSURES

Puerperal morbidity includes any case with fetus over 28 cms. long, 400 gms. weight, or 22 weeks duration.

*0 DeLee standard—any patient (intrapartum or postpartum) who has an oral (mouth) temperature of 100° F. on one (or more) occasion(s) is febrile.
*1 British standard (condensed from original report—see card in file). Puerperal morbidity to include all fatal cases and all others having an oral (mouth) temperature of 100° F. or higher on any two days, excluding the first postpartum day and ending with the eighth day.
*2 Strasbourg standard (condensed from original report—see card in file). Puerperal morbidity includes all patients whose temperature *rises above* 38°C. (100.4° F.) one time and is so maintained *for more than* 12 hours, except during the first 24 hours of the puerperium.
3 Hypotension (systolic readings)—100 mm. Hg. or less on two or more occasions.
**4 Hypertension (systolic readings)—130-149 mm. Hg. must occur on at least two different readings.
**5 Hypertension (systolic readings)—150-179 mm. Hg. on any one reading.
**6 Hypertension (systolic readings)—180-209 mm. Hg. on any one reading.
**7 Hypertension (systolic readings)—210 and over mm. Hg. on any one reading.
8-9 Open.

* Temperatures taken orally—if rectally, subtract 1° F., or if axillary add 1° F. for corrected reading.
** Record only the greatest elevation of blood pressure.

COLUMN 77 MATERNAL WEIGHTS AND TYPES

Weight—last antepartum weight.

0 Less than 45 Kg.
1 46 to 55 Kg.
2 56 to 65 Kg.
3 66 to 75 Kg.
4 76 to 85 Kg.
5 86 to 95 Kg.
6 96 and over Kg.
7 Type A—masculine constitution, male hirsutes, funnel pelvis.
8 Type B—Dystrophia dystocia syndrome — normal pelvis but short squatty stature, spatuloid fingers, etc.
9 Type C—visceroptotic—long abdomen, relaxed, sagging abdomen; relaxed pelvic structures, etc.

COLUMN 78 MATERNAL HEIGHTS

0 Less than 145 cm.
1 146 to 155 cm.
2 156 to 165 cm.

3 166 to 175 cm.
4 176 and above.
5 Consultation—medical.
6 Consultation—medical specialties (dermatology, neurology, psychiatry).
7 Consultation—surgical.
8 Consultation—surgical specialties (genito-urinary, orthopedic, head specialist, neurology).
9 Billings patient (for Mrs. Whipple)—patient in Billings Hospital—not in Lying-in as Gyn. on S. 5, etc.

COLUMN 79 AUTOPSY, GLYCOSURIA (NON-DIABETIC) AND ANTENATAL CARE

0 Autopsy—adult.
1 Glycosuria (non-diabetic).
2 to 5, open.
6 Antenatal Care I. Registered in first trimester and received adequate observation.
7 Antenatal Care II. Registered in second trimester and received adequate observations thereafter—or registered in first trimester but had inadequate followup.
8 Antenatal Care III. Registered in last trimester, with adequate follow-up thereafter—or registered in second trimester, with inadequate follow-up.
9 Antenatal Care IV. Received no antenatal care or wholly inadequate care, if registered.

COLUMN 80 TREATMENT AND CONDITION ON DISCHARGE

0 Expectant (Obs. and Gyn.).
1 Operative—exclude applications of radium, biopsy, D. and C., etc.
2 Irradiation—X-ray and/or radium, radon.
3 Diagnostic procedures—D. and C., biopsy, visualization, insufflation, etc.
4 Other forms of treatment.
5 Return case—no additional therapy.
6 Died in hospital.
7 Discharged from hospital in unsatisfactory state.
8 Open.
9 Transferred to other service—not Obs. or Gyn.

DIRECTIONS FOR FILLING OUT SUMMARY SHEET (OBSTETRIC PATIENTS)

The resident is to fill out the top of the blue summary sheet according to the plan outlined below. Write only positive facts which apply to each case.

FINAL DIAGNOSIS
Specify
1. No complications
2. Complications
Specify main diagnosis

PREGNANCY
1. Weeks of gestation
2. No complications
3. Complications
Specify

LABOR—Onset, course and termination
1. Duration
2. No complications
3. Complications
Specify

PUERPERIUM
1. Days in the Hospital
2. No complications
3. Complications
Specify

ON LAST LINE

1. Fetal death
2. Neonatal death
3. Baby left in Hospital
4. Baby discharged with mother
5. No complications
6. Complications
   Specify

DIRECTIONS FOR FILLING OUT SUMMARY SHEET (GYNECOLOGIC PATIENTS)

GYNECOLOGIC CASES SHOULD HAVE THE TOP PART OF THE BLUE SUMMARY SHEET FILLED OUT ACCORDING TO THE FOLLOWING PLAN:

1. Final Diagnosis
   State final and principal diagnosis.
2. Under Pregnancy, state the
   Pre-operative diagnosis.
3. Under Labor, state the
   Operative procedures.
4. Under Operations, state the
   Structures removed, if any.
5. Remaining lines
   1. Post-operative days in hospital
   2. Post-operative complications, if any
   3. Condition on discharge from hospital.

OUTLINE FOR GYNOCOLOGIC OPERATIONS

I Personnel
II Operation
III Pre-operative Diagnosis
IV Diagnosis During Operations
V Organs Removed (in detail)
VI Indications for Operation:
VII Findings under Anesthesia:
   A. Abdominal Palpation
   B. Pelvic Examination
      1. External genitalia
      2. Internal genitalia
VIII Preparation
IX Incision
   A. Type
   B. By whom
   C. Difficulties encountered—bleeding, adhesions, etc.
X Detailed description of gross pathological findings in situ.
XI Detailed description of operative technique mentioning by whom each step was done, type of suture material, type of instruments, etc.
XII Closure by layers
   A. By whom
   B. Type of suture material
   C. Number and type of non-absorbable sutures used.
XIII Packs or Drains or Retention Catheter, Radium, etc.
XIV General Therapy besides anesthesia or operation, such as Blood transfusions, intravenous solutions, hypodermoclysis, stimulants, etc. By whom and why.
XV Summary of condition of patient at termination.
XVI Structures:
   A. Removed prior to this operation.
   B. Removed at this operation.
   C. Genital structures or appendix now remaining after operation.
XVII Dictator and date.

OUTLINE FOR HISTORY OF OPERATIVE DELIVERIES

OPERATION For example: Episiotomy, Manual rotation of the head. Mid forceps. Perineorrhaphy.

INDICATIONS

1. Mother
2. Baby, e.g., Second stage of two hours. No progress for one hour with the occiput posterior. F.H.T. 100, slightly irregular. Meconium in the liquor amnii.

CONDITIONS

1. Pelvis
2. B.O.W. (if ruptured, how long)
3. Cervix
4. Station
5. Rotation
6. F.H.T.
7. Mother's condition and pulse

e.g. Pelvis contracted in anteroposterior diameter.
Cervix completely dilated. Head below the spines.
Small fontanelle 110°, Mother's pulse 116,
F.H.T. 130

OPERATION

1. Preparatory
2. Delivery

e.g. Episiotomy—Duehrssen's incisions. Gauze or bag induction. Version. Manual rotation of the head. Describe fully the operation of delivery. Early expression of the placenta.
e.g. Episiotomy to the sheath of the levator. Manual rotation of the head until the small fontanelle points L30′. Forceps applied to the sides of the head, fontanelle points L10′. Small fontanelle rotated to 0′ with traction. Moderate amount of traction used.
Repair—of the cervix—2 interrupted cgs., of the vagina—cont. cgs., of the perineum—3 buried interrupted cgs., 4 figure of eight sws.

RESULTS

1. Mother
   a. General condition
   b. Condition of the perineum, of the cervix.
      e.g. Cervical tear of 3cm. at 6 o'clock. Extension of the episiotomy wound 4cm. in vagina.
2. Child—general condition.
      e.g. Child moderately asphyxiated.

DYSTOCIA

1. Primary, secondary, or relatively weak pains.
2. Disproportion
3. Faulty attitude

e.g. Secondary weak pains. Occiput posterior.
Moderate degree of flat pelvis.

INSTRUCTIONS FOR WRITING CESAREAN SECTION HISTORIES

INDICATIONS

1. On the part of the mother.
2. On the part of the foetus.

CONDITIONS

1. Patient in labor? How long?
2. Pains, how frequent? Strength?
3. Cervix? B.O.W. intact? Ruptured? Number of hours.
4. Station.
5. Condition of mother?
6. Condition of foetus? F.H.T.? Count—reg. irreg.?
7. How many vaginals?
8. Who called in consultation?

OPERATION

Write in detail.

1. Incision
   a. Skin
   b. Fascia
   c. Muscle
   d. Peritoneum
   e. Uterus
2. Location of bladder, high or low? On ant. wall?
3. Was peritoneum dissected up from uterus?

4. How and what portion?
5. Any adhesions?
6. Any manipulations of intestines or omentum?
7. Method of delivery of the child?
8. Was a suction pump used on foetus or spill?
9. Location, high or low, method of delivery of placenta.
10. Amount of hemorrhage from wound? Uterus?
11. Pituitrin and ergot subcutaneous, how much? Intrauterine? How much?
12. Repair of uterus?
13. Complications of repair, varicose veins, bladder, extension of incision.
14. Other operations and indications for each?
    Sterilization
    Porro
    Tumors
    Appendix, etc.
15. Repair of abdominal wound? Drainage?
16. Condition of patient at end of operation?
17. Transfusion, blood, salt solution, tamponade, etc.
18. Condition of foetus at end of operation?
19. Tracheal catheter?
20. Anaesthetic, kind, how patient took? How long?
21. Catheter removed from bladder, injury to bladder?

PART VI

Applications in Medical Research and in Hospitals

CHAPTER III

A Method of Combining Anesthetic and Surgical Records for Statistical Purposes*

By

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STATISTICAL reports relating to anesthesia have been noticeably barren of convincing evidence. One of the obvious reasons for this fact is the lack of uniformity in defining anesthetic results. For example, one authority may admit an anesthetic fatality only when the patient dies on the operating table or before regaining consciousness, while on another service every patient dying within a given length of time is credited to anesthesia. The same is true of other anesthetic data.

Need for Uniformity in Collecting, Correlating and Reporting Anesthetic Statistics

Some anesthetists will attempt to dissociate postoperative complications as resulting from illness, operation, or anesthesia, while another group will include all complications occurring after anesthesia as related to it. Reports too often consider the agent and disregard the technique, the type of operation, the operating surgeon, preoperative physical condition of the patient and so forth.

Anesthesia records, where they are kept at all, are certainly not uniform but differ with almost every institution. The methods of collecting these records are quite as variable. Too often the surgical record is kept entirely separate from the anesthetic record, and frequently there is no opportunity to correlate the two. Postoperative sequelae may not be studied in relation to preoperative condition, anesthesia and so forth. Autopsy findings are frequently interpreted with only the clinical history in evidence. Results reported are not rarely difficult to interpret because the data are incompletely kept or not uniformly defined. Records of positive information are sometimes presented, while the quite as essential negative information is disregarded. A vast amount of useful material has been wasted and many important lessons for the surgical team lost because of this faulty system or lack of system.

* Read during the Twelfth Annual Congress of Anesthetists, the International Anesthesia Research Society, in joint meeting with the Associated Anesthetists of the United States and Canada, the Eastern Society of Anesthetists, the Mid-Western Association of Anesthetists and the Southern Association of Anesthetists, Clinical Congress of Surgeons Week, Congress Hotel, Chicago, Ill., October 9-12, 1933. Reprinted here from *Anesthesia and Analgesia*, May-June, 1934, by special permission from the author.

At the present time there is little concerted effort to gain uniformity in collecting, correlating and reporting anesthetic statistics. One serious difficulty in planning and adopting a satisfactory system is lack of a compact record. Such a record should contain accurate positive and negative information, not only of the anesthetic procedure with such observations as may be related to it, but correlate the clinical preoperative findings, the surgical treatment, immediate and remote results. Where comprehensive records are available, the task of securing and tabulating material from the voluminous case record or even the isolated anesthetic chart has been monotonous, time consuming, and difficult to carry out, A method for conveniently recording correlated clinical, anesthetic, surgical and postoperative results has been desired.

Tabulating and Sorting Aids

A step toward the solution of this difficulty has been made by the use of a Hollerith tabulating machine; an apparatus capable of sorting and tabulating results from a special card prepared for it. Early in 1928, the Los Angeles County General Hospital* incorporated such a system for collecting and tabulating statistics on the various services at that hospital. Since then, other large medical centers have adopted the tabulating card in their records and statistical departments. Dr. C. H. Peckham has data on more than forty thousand obstetrical cases so indexed at Johns Hopkins Hospital.* At the Presbyterian Hospital in New York* all records of patients discharged are summarized on the tabulating cards. The New York Hospital and Cornell Medical Association* have employed it in special studies. At the Mayo Clinic its extensive use includes special studies and statistics for all services. From there, Tovell and Dunn** reported its adoption for anesthesia study records.

The tabulating and sorting machines are rented from the International Business Machines Corporation, but the cards, after being punched on an inexpensive punching machine, may be sent out for tabulating and counting. The tabulating cards, made up after any desired code, require small storage space. This advantage is highly desirable because the space required to store complete sets of clinical records over a period of years is almost prohibitive.

New Anesthetic Study Record, Tabulating Card and Code Charts

A new anesthetic study record or chart has been adopted at the State of Wisconsin General Hospital to facilitate the ready collecting and transcribing of data to the tabulating card. The front of this record is shown in Figure 173 and contains information of the operation and the anesthetic procedures in the operating room. The patient's name, operation proposed, risk, premedication and so forth, is completed before the anesthetic is administered. The record of the anesthetic agent, time, and patient's condition during operation as shown by blood pressure, pulse, respiration, depth of anesthesia, reactions, complications and so forth, is completed during the course of the operation. The record

* *Personal Communications.*

** Tovell, Ralph M. and Dunn, Halbert L.: Anesthesia Study Records, *Anesth. and Analg.* 11, 37-41, No. 1, Jan.-Feb., 1932.

The University of Wisconsin
STATE OF WISCONSIN GENERAL HOSPITAL
ANESTHESIA RECORD

No. _____ Date _____
Ward _____ Risk: E A B C D DD
Name _____ Age _____ O. B. _____
Op. Proposed _____ Time _____ S. _____
Prelim. Med. _____ S I U

M. 15 30 45 15 30 45 15 30 45 15 30 45

N_2O
C_2H_4
ETHER
PRO
CO_2

O₂% OR CC/MIN
700 600 500 400 300 200 100

PLANE OF ANESTHESIA 1 2 3 4

180 160 140 120 100 80 60 40 20 0

15 30 45 15 30 45 15 30 45 15 30 45

REMARKS

S I U

Agents _____ Technic _____
Operation _____
Surgeons _____
Anesthetists _____
Drains _____
Sponge ( ) Needle ( ) Instruments ( ).
Counts Checked By:
Instrument Nurse _____
Circulating Nurse _____

Form No. 162—5-34—5M

FIG. 173—Operative Record

Name _____ (Last Name) (First Name) (Mr., Mrs., Miss) S. C. P.
Address _____
M. F. Age Wt. Ht. Compl. T. P. R. B. P.
Hb. R. B. C. W. B. C. Sugar Chlor. Cong.
Anes. Hist.—No. Here Not here S-U. B. M. R.

PREOPERATIVE	RESPIRATORY	POSTOPERATIVE
Tb: Ac. Pas. Cough. None.		None
Bronchitis. Pharyngitis. Pleurisy.		Bronchitis. Pharyngitis. Pleurisy.
Empyema. Emphysema. Abscess.		Cough
Infect. Ex. Tb. Pneu.		Rhinitis. Obstruct.
Bronchiectasis. Hiccough.		Hiccough. Vit. Capac.
Collapse. Asthma.		Pneu: L B H
Vital Cap. Br. Hold.		Collapse
Airway. Oral Sepsis.		Misc.
Misc.		

CIRCULATORY

Vs. Lesion. Angina. None.	None
Tachycard. Bradycard. Arrhyth.	Tachycard. Bradycard. Thyroid Cr.
Hyperten. Hypoten. C. V. B.	Severe Drop B. P.
Shock. Fibrilla. Arterios.	Shock. Dilat.
Myo. Degen. Func. Cap. I—IIA—IIB—III	Embolus. Phlebitis.
Embolus. V. M. Instabil.	Misc.
Misc.	

GENITO-URINARY

Uremia. N. P. N. Incontin. None.	None
Hematuria. Acetonuria. Albumin.	Cystitis. Hematuria. Albumin.
Nephritis: Ac. Chr. Cystitis.	Nephritis
Impaired Funct. Retent.	Incontin. Retent. Impair. Funct.
Misc.	Misc.

GASTRO-INTESTINAL

Distent. Nausea & Emesis. None.	None
Obstruct. Perfor.	Ileus. Parotitis. Bl. St.
Cond. Rectum	Distent.: M. S. Nausea & Emesis
Misc.	Misc.

CENTRAL NERVOUS SYSTEM

Lues. Parathes. Paraly. None.	None
Irrational. Br. & Cord Lesion.	Paraly. Parathes.
Meningitis. Headache: M. S.	Headache: M. S.
Psy. Misc.	Psychosis. Irrat. Exc.
	Misc.

OBSTETRICAL

Toxemia—Yes. No. Para.	Pain Relief —Yes. Partial. No.
Presentation	Obstet. Satisfied —Yes. Partial. No.
Misc.	Baby Cond. Good—Yes. Partial. No.
	Misc.

MISCELLANEOUS

Spec. Tox. Malig. None.	Fever
Dr. Addict. Thymus. Other.	Other
Anem.—S. P. Epilep. Anox.	
Leuk. Diabetic. Hypomet.	
Acidosis. Alkalosis. Obes. Senil.	Medication
Other	

Final Comment

Signed _____ (Anesthetist)

FIG. 174—Complications

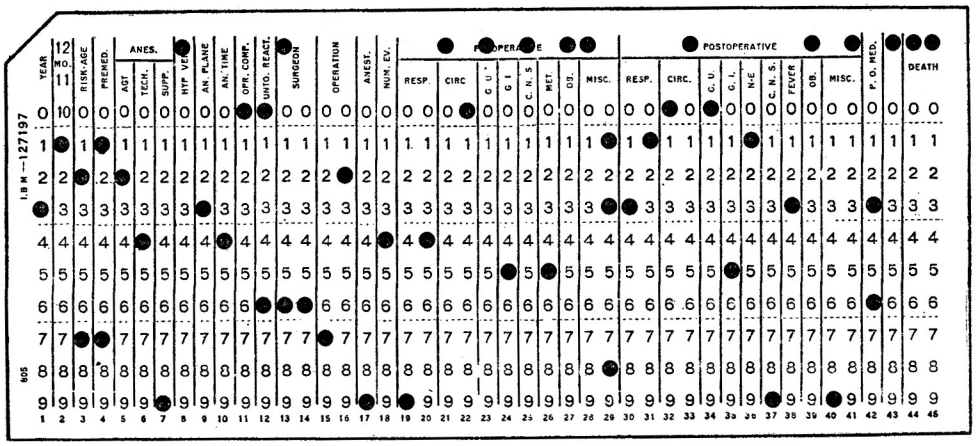

FIG. 175

Punched Card

of anesthetic technique, operation, surgeon and so forth, is filled in at the completion of the anesthesia. The reverse of the chart (Fig. 174) is a resumé of the findings, clinical and laboratory, preoperatively and postoperatively. There is also a final comment by the anesthetist which is completed when the patient is discharged from the hospital. Here the summarization of the case may be made with the anesthetist's reaction to success or failure of the agent and technique. If death has occurred, a complete autopsy record, when available, is attached to the chart.

The preoperative data, laboratory and clinical, are secured when the patient is seen by one of the anesthetic staff the day before operation and it serves as a guide in ordering the preoperative medication for that patient, as well as in determining upon a plan of anesthetic management in the operating room. Such data take into account negative information as well as positive. The postoperative information is transferred from the bedside notes or secured through personal interview by the anesthetist who administered the anesthetic, when the patient is visited by him on the first to third postoperative day and upon his subsequent visit during the second week after operation. It is completed with final comment on the case when the patient's complete hospital record is reviewed before it is finally filed in the permanent hospital record room. With this record complete, the tabulating card (Figure 175) is punched. Each positive or negative question is represented by numerals and exact instructions and definitions are followed. A large code chart (Figure 176) has been prepared to facilitate rapid punching and is a key to the instructions. Each numeral or pair of numerals on the card corresponds to a datum on the anesthesia record and is represented on the code. When some condition occurs that is rarely encountered and no provision is made for its inclusion on the punched card, it may be written upon the reverse side of the card and a key number punched to indicate that fact.

The system has not been in use for a sufficient time to gather statistics from a large series of cases. However, the experience gained by employing

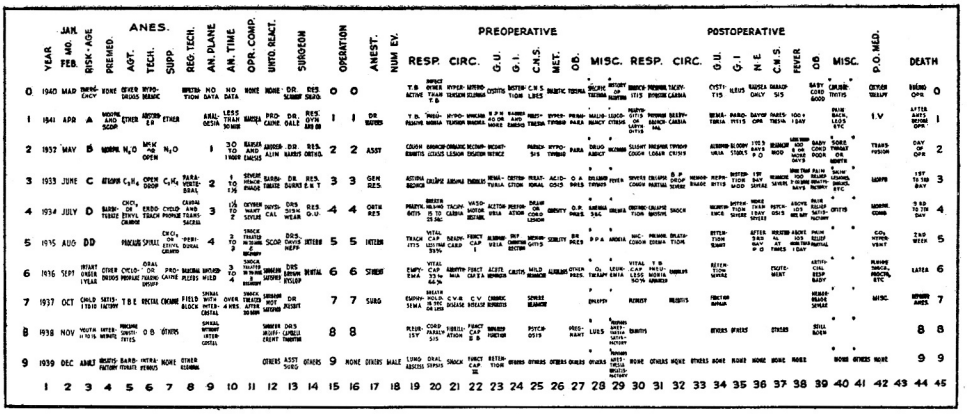

FIG. 176

Code Chart

it during the last year has demonstrated its usefulness in saving of time and labor.

Formerly if statistical data were to be recorded from a series of cases, or during a certain time, it was necessary to review the anesthetic charts of that series of for that period. This was labor that could not well be delegated to office personnel, but rather required attention of a physician, familiar with the procedures involved, to properly interpret the records. Now the machine will quickly and accurately sort out the required information and tabulate it.

Compilation of Data

The multiplicity of statistical facts available from the completed punch card cannot be briefly enumerated. The diagram (Figure 177) lists under general terms the data that may be compiled. That which primarily concerns the patient is listed at the top, the anesthetist to the left, the surgeon to the right and the data for hospital statistics at the bottom. Any and all of these facts are readily correlated as shown by the direction of the arrows.

The tables shown represent actual studies on small numbers of cases and are only included to demonstrate some of the many ways in which the system may be employed. They are not presumed to have statistical value, representing as they do a very brief series. Table I uses one thousand consecutive operations. The anesthetists are considered. The number of cases done and the risks encountered are shown. The time each was successful in entirely satisfying the surgeon as well as the times the surgeon was indifferent or not satisfied with the anesthesia is listed. Deaths and when they occurred and the agents and technique employed are also enumerated.

In Table II, five hundred successive ether cases are divided in relation to the plane of anesthesia. The deepest plane of third-stage to which the patient was carried at any time during the anesthesia is the basis. The postoperative respiratory complications are enumerated.

Table III is an incomplete study of cholecystectomies. The per cent of each

TABLE I

Anesthetist	A	B	C	D	E	F	Total
Cases	297	278	155	154	109	7	1000
Risk:							
Emergency	65	45	24	43	22	0	199
A	9	6	2	9	8	0	34
B	95	86	49	66	48	2	346
C	88	116	55	31	24	5	319
D	37	25	23	5	6	0	96
DD	3	0	2	0	1	0	6
Surg. Satisf.	285	251	140	144	107	7	935
Surg. Indiff.	3	11	5	2	0	0	21
Not Recorded	5	14	5	3	1	0	28
Surg. Not Satisf.	4	2	5	5	0	0	16
Deaths:							
1-3 Days	0	3	0	1	0	0	4
3-7 Days	5	1	4	1	0	0	11
2nd Week	0	4	0	1	2	0	7
Later	0	0	0	1	7	0	8
Agent:							
Ether	75	101	71	45	28	4	324
N_2O	28	36	7	51	10	0	132
C_2H_4	127	87	46	46	51	3	360
$CHCL_3$	0	1	1	0	1	0	3
T. B. E.	5	41	17	3	4	0	70
Procain	57	12	3	8	19	0	99
Others	0	0	0	1	0	0	1
Technique:							
CO_2 ABS.	168	184	84	102	82	6	626
Open G-O	9	4	8	0	2	0	23
Open Drop	13	10	1	10	4	1	39
Endotrach.	31	18	37	2	10	0	98
Rectal	5	12	3	3	4	0	27
Spinal	28	20	6	8	6	0	68
Reg. Block	28	21	11	0	1	0	61
Obstet.	15	8	5	28	0	0	56
Others	0	1	0	1	0	0	2

TABLE II

Ether Anesthesia—500 Cases

Postoperative Respiratory Complications

Plane of 3rd Stage	Cases	None	Bronch.	Pharying.	Cough	Hic-Cough	Pneumonia Bronch.-Lobar	Collapse Part.
1	57	54	0	1	0	1	1	0
2	256	234	1	5	10	3	0	1	0
3	166	138	0	5	19	5	3	0	3
4	24	18	0	0	6	0	1	0	0
Totals	500	444	1	11	35	9	5	1	3

sex is shown. A few of the preoperative, operative and postoperative complications are included. A partial list of treatment received after operation is noted.

Table IV compares the thyroidectomy cases of two surgeons, as to risk, with some of the postoperative complications and deaths.

The speed with which statistics may be compiled with the completed punched card record surpasses that of any record system in our experience. The information contained in the four tables shown was easily secured in less than an hour at the sorting machine. Studies at one's disposal as suggested in the diagram (Figure 177) may be made at any time with comparable celerity. Preparing the finished record demands more time than it was previously our practice to employ in completing such files. However the adoption of the

TABLE III

Cholecystectomies

Sex:	
Male	21.0%
Female	79.0
Preop. Complications, Respiratory:	
Passive Tuberculosis	2.5
Cough	2.5
Pharyngitis	40.0
Bronch. Asthma	1.2
Emphysema	5.0
Oral Sepsis	30.0
Miscellaneous:	
Drug Addict	1.2
Secondary Anemia	2.5
Malignancy	2.7
Fever	5.0
Leucocytosis	8.7
Operative Complications:	
Nausea	2.7
Nausea & Emesis	1.2
Sever O_2 Want	1.2
Postop. Complications, Circulatory:	
Severe Drop. B. P.	15.0
Shock	2.5
Hemorrhage	1.2
Postop. Treatment:	
Transfusions	2.5
Oxygen Therapy	2.7
I. V. Fluids	70.0
Subcut. Fluids	90.0

TABLE IV

Thyroidectomies—Gas-Oxygen Anesthesia

Surgeon	A	B	Total
Cases	29	39	68
Risk:			
B	3	8	11
C	24	28	52
D	2	3	5
P. O. Complications:			
None	14	9	23
Pharyngitis	5	7	12
Cough	3	6	9
Resp. Obstruct.	0	1	1
Tachycard.	3	4	7
Bradycard.	1	1	2
Thyroid Crisis	0	1	1
Cystitis	1	0	1
Slight Retent.	2	1	3
Distent. Mod.	1	3	4
Headache Mod.	2	2	4
Headache Severe	0	1	1
Irrational	0	1	1
Excitement	0	1	1
Nausea & Emesis:			
Nausea Only	1	1	2
Nausea & Emesis Op. Day	5	17	22
1-3 Days Mild	1	8	9
1-3 Days Severe	1	0	1
After 3rd Day	0	1	1
Deaths	0	1	1

anesthetic chart with complete preoperative and postoperative information has been found to facilitate collecting this desirable information and has been of inestimable value in conducting the anesthesia, specifying the preanesthetic medication and making postoperative suggestions. With this record complete some three to five minutes is necessary to prepare the punched card. This labor is best done by members of the anesthetic staff who may properly interpret the charts and who are entirely familiar with the entire system. After a short experience it was found inadvisable to delegate this work to others. It is advantageous to prepare the punched card relatively soon (two or three weeks) after administering the anesthetic. Later information that should be included may be added since it is our practice to write upon the card the case number. This facilitates referring to the patient's complete record if desired, as well as adding additional data.

Summary

A system for collecting comprehensive data for surgical and anesthetic procedures is offered. The use of tabulating cards and a sorting machine makes such data immediately available for statistical purposes with a minimum of labor.

Information from voluminous case records may be condensed on cards and stored in a small space.

Securing and recording the entire preoperative condition of patients has proven of definite value to the anesthetist.

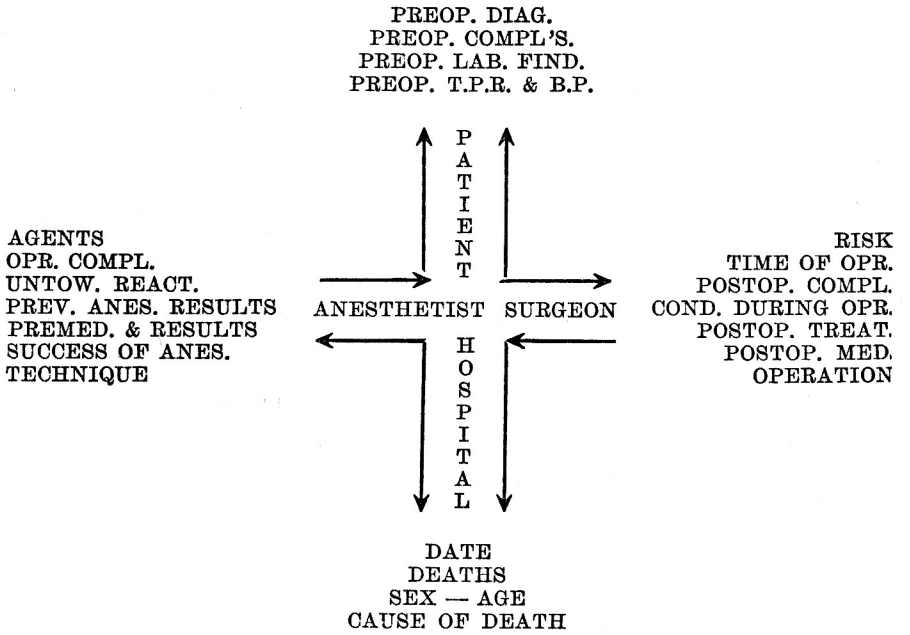

FIG. 177

Study diagram

The task of accurately preparing the complete records has been found best done by members of the anesthetic staff.

A method is presented to secure information easily for individual surgeon and anesthetist; correlating anesthetic agents and techniques with operative procedures, postoperative complications and postmortem findings; preoperative condition of the patient with postoperative sequela; preliminary medication and results. Statistics on operations, risks, anesthetic methods, age, sex, dates, postoperative treatment, deaths, time and cause of death are also available.

PART VI

Applications in Medical Research and in Hospitals

CHAPTER IV

Studies in the Field of Public Health

By

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WE are glad to have our students, particularly those who expect to pursue research or administrative activities involving statistical technique, become acquainted with the system of mechanical tabulation. If their work requires the preparation of reports of vital statistics on any large scale they will find the use of the tabulating card advantageous. In some kinds of research work they will likewise find it helpful.

Most studies in the field of public health are not made on the published reports of vital statistics and statistics of disease but are based upon records that are collected by various public health organizations such as child health clinics, maternity clinics, cancer clinics, and the like. There are also studies planned and made on data collected by house to house surveys.

In medical studies there are often so many factors involved that only from a large number of cases can conclusions be drawn with any assurance that the indicated relations have any reality. The material for these studies is usually obtained from hospital records. By far the most satisfactory way to handle the data is by means of punched cards. The items that are thought to have a possible bearing on the problem are listed, and a form drawn up in accordance with which information about each case is punched on a separate card. It is then an easy matter to sort the cards and read from the machine the number of cases of each sex, age or diagnosis, or to find the numbers according to some double classification such as age and diagnosis, or treatment and result. To make such tabulations by hand is very tedious and it is almost impossible to make them correctly. The sorting machine does the work quickly and accurately.

Example I, Chronic Disease Survey

The outstanding public health problem of the present day is the control of chronic diseases of the middle-aged.

Two generations ago the average age at time of death of all individuals in Massachusetts was about thirty-one years. Today it is around fifty-one,—a gain of some twenty years. In the same period the average age at time of death of individuals over fifty has decreased a fraction of a year. The increase for total ages has been accomplished largely through public health measures.

More adequate sanitation of the environment with improved water and sewerage systems, advances in bacteriology and the attack on communicable diseases, combined with a concerted attempt to make personal hygiene real rather than theoretical, have all had a part in this reduction. Tuberculosis, typhoid fever, and diphtheria, as well as other diseases have been decreasing. The infant and maternal welfare work has saved the lives of many children, and, as a result, the average age of the population has increased; but for those individuals over fifty, no such rosy picture is seen. Here the age specific death rates have been mounting, and the expectation of life has decreased.

For several years the Massachusetts Department of Public Health has taken cognizance of this situation, and in 1929 began a systematic study of the problem. This included a review of the death records; questionnaires to hospitals, doctors and nursing homes; data collected from the Massachusetts State-aided cancer clinics; and a house-to-house survey of some 75,000 people.

This material has been analyzed in a book "Cancer and Other Chronic Diseases in Massachusetts" by Bigelow and Lombard and published by Houghton Mifflin Company. This book contains 135 tables. While a few tables were prepared by a laborious hand-sort, most of them were compiled by means of the mechanical sorter. The codes used in collecting the data on cancer and chronic diseases are practically similar to those shown on the accompanying forms.

In making the various tabulations, it was necessary to run the cards through the machines many times. One table alone required eleven sub-sorts. As many tables were constructed which were not eventually printed, a conservative estimate indicates that the average card was run through the machine some five hundred times.

The material was collected by individuals going to the various houses. In most cases the underlining method was used on the code, and in a few, such as present weight, the figure was written down and later transferred to the code after the necessary computations had been made.

The first essential of any statistical study is accurate data, in order to insure uniform interpretation of the questions asked. A special course of training was given to a selected group of surveyors. Each day the records collected on the previous day were discussed at group conferences, thus avoiding the possible misinterpretation by any individual surveyor for more than a few records.

The punched cards used were the plain white cards. The data were punched and then checked for errors in punching. If a person had more than one disease, cards were punched for each disease. After the data were assembled they were analyzed and many phases of their statistical soundness reviewed.

Example 2, Appendicitis

A study of appendicitis recently made by Dr. Irving J. Walker* is an excellent illustration of the use of punched cards to facilitate medical re-

* Walker, Irving J., M.D., A Comparative Mortality Study of Acute Appendicitis. New England Medical Journal, Vol. 208, No. 3, Jan. 19, 1933.

search. The rising mortality rate from appendicitis raised the question whether there is an increase in the incidence of the disease in the population, or an increase in the operative mortalities. The former cannot be answered conclusively from hospital records, but the latter can, and is the question Dr. Walker undertook to settle. He compared the experience of the Boston City Hospital during two periods of four years each, 1907-1910, and 1927-1930. The code he used is reproduced here (Fig. 178). A simple two-way table (Table I.) of condition at discharge (col. 20 of code sheet) against year of admission (col. 1) shows that operative mortality has decreased. Table II brings in a third factor (col. 12) and shows that in each type of appendicitis operative mortality was lower in 1927-1930 than in 1907-1910.

TABLE I

MORTALITY OF APPENDICITIS BY YEARS

	Total	*Recovered*	*Died*	*Mortality*
1907	157	132	25	15.9%
1908	192	162	30	15.6%
1909	180	159	21	11.6%
1910	230	206	24	10.4%
1907-1910	759	659	100	13.1%
1927	526	491	35	6.6%
1928	493	460	33	6.6%
1929	492	466	26	5.2%
1930	595	566	29	4.8%
1927-1930	2106	1983	123	5.8%
Both Groups— 1907-1910 and 1927-1930	2865	2642	223	7.7%

TABLE II

MORTALITY ACCORDING TO TYPE OF APPENDICITIS

	1907-1910			1927-1930		
Type of Appendicitis	*Total*	*Died*	*Mortality*	*Total*	*Died*	*Mortality*
Acute unruptured	264	7	2.6%	1174	18	1.5%
Acute unruptured with fluid (not peritonitis)	41	5	12.2%	265	4	1.5%
Appendix abscess	289	37	12.8%	328	32	9.7%
Acute with spreading peritonitis	124	27	21.8%	204	24	11.8%
Acute with general peritonitis	41	24	58.5%	135	45	33.3%

Example 3, Eye-Diabetes

Dr. William P. Beetham and Dr. J. H. Waite recently made an extensive study of about 4,000 cases of diabetes from the records of Dr. Joslyn's Diabetes Clinic with respect to factors of diabetes and other factors of ocular pathology. They selected a random control group—non-diabetics—from the cases of the Massachusetts General Hospital who had eye examinations similar to the diabetics. The purpose of the study was to investigate the eye changes that are peculiar to diabetes. The code used (Fig. 179) was intricate but suitable for their purposes and well adapted for use with punched cards. The results

Volume.....*Page*.....
(Write)

1. Year of Admission: (1) 1907 (2) 1908 (3) 1909 (4) 1910 (5) 1927 (6) 1928 (7) 1929 (8) 1930.

2. Month of Admission: (1) Jan. (2) Feb. (3) Mar. (4) April (5) May (6) June (7) July (8) Aug. (9) Sept. (0) Oct. (X) Nov. (Δ) Dec.

3, 4, 5. Age:..... (1) 1–5 (2) 6–10 (3) 11–20 (4) 21–30 (5) 31–40 (6) 41–50 (7) 51–60 (8) 61–70 (9) 71–80 (0) 81–90 (X) 91–100.
(Write age)

6. Sex: (1) Male (2) Female.

7. Duration of time from onset of symptoms before calling physician to home:
(a) Hours: (1) 0–1 (2) 2–3 (3) 4–5 (4) 6–7 (5) 8–9 (6) 10–11 (7) 12–13 (8) 14–15 (9) 16–17 (0) 18–19 (X) 20–21 (Δ) 22–23.
or
(b) Days: (1) 1 (2) 2 (3) 3 (4) 4 (5) 5 (6) 6 (7) more than six days.

8. Duration of time from first visit of physician to entrance to Hospital:
(a) Hours: (1) 0–1 (2) 2–3 (3) 4–5 (4) 6–7 (5) 8–9 (6) 10–11 (7) 12–13 (8) 14–15 (9) 16–17 (0) 18–19 (X) 20–21 (Δ) 22–23.
or
(b) Days: (1) 1 (2) 2 (3) 3 (4) 4 (5) 5 (6) 6 (7) more than six days.

9. Duration of time from onset of symptoms to entrance to Hospital:
(a) Hours: (1) 0–1 (2) 2–3 (3) 4–5 (4) 6–7 (5) 8–9 (6) 10–11 (7) 12–13 (8) 14–15 (9) 16–17 (0) 18–19 (X) 20–21 (Δ) 22–23.
or
(b) Days: (1) 1 (2) 2 (3) 3 (4) 4 (5) 5 (6) 6 (7) more than six days.

10. Duration of time from entrance to Hospital to time of operation:
(a) Hours: (1) 0–1 (2) 2–3 (3) 4–5 (4) 6–7 (5) 8–9 (6) 10–11 (7) 12–13 (8) 14–15 (9) 16–17 (0) 18–19 (X) 20–21 (Δ) 22–23
or
(b) Days: (1) 1 (2) 2 (3) 3 (4) 4 (5) 5 (6) 6 (7) more than six days.

11. Operator..... (1) Visiting Surgeon (2) Resident Surgeon (3) Interne.
(Write name) (Do not score)

12. Type of appendix: (1) Acute unruptured.
(2) Acute unruptured with fluid (not peritonitis).
(3) Appendix abscess.
(4) Acute with spreading peritonitis.
(5) Acute with general peritonitis.
(6) Periappendicitis secondary to other intra-abdominal lesions.

13. Operative procedures: (1) Appendectomy. (7)
(2) Incision without appendectomy. (8)
(3) Appendectomy and enterostomy. (9)
(4) Incision and enterostomy. (0)
(5) Appendectomy and multiple incisions.
(6) Other operative measures.....
(Write in name of operation)

14. Kind of Drains: (More than one item can be scored):
(1) Gauze. (2) Cigarette. (3) Rubber tissue. (4) Rubber tubing. (5) Other types of drains.

15. Number of Drains: (0) None (1) One (2) Two (3) Three (4) Four (5) more than four.

16. Preoperative complications: (More than one item can be scored.)
(1) Bronchitis. (2) Pneumonia. (3) Tuberculosis. (4) Heart disease.
(5) Arterio-sclerosis. (6) Diabetes. (7) Other diseases.....
(8) (9) (Write in names of diseases)

17. Complications arising postoperatively: (More than one item can be scored):
(1) Peritonitis. (5) Local abscess in region of caecum. (9) Septicemia.
(2) Hemorrhage. (6) Pelvic abscess. (0) Pulmonary embolism.
(3) Pneumonia. (7) Subdiaphragmatic abscess (X) Cardiac disease.
(4) Intestinal obstruction. (8) Liver abscess including pylephlebitis. (Δ) Other diseases.....
(Write in names)

18. Wound healing: (1) Remained clean. (2) Became infected.

19. Secondary operations:
(1) Opening abscesses. (4) Resuture of wound. (7) (0)
(2) Operation for obstruction. (5) Empyema. (8) (X)
(3) Transfusion. (6) Other operations..... (9) (Δ)
(Write in names)

20. Condition at discharge: (1) Recovery. (2) Death.

21. Culture reports: (1) Colon bacillus. (3) Streptococcus viridans. (5) Mixed infections.
(2) Streptococcus hemolyticus. (4) Staphylococcus aureus. (6) Other organisms than above noted.....
(Write in names)

22. Was post mortem examination done? (1) Yes. (2) No.

23. Primary cause of death from importance of disease causing death:
(1) General peritonitis. (6) Cardiac failure.
(2) Lobar pneumonia. (7) Intestinal obstruction.
(3) Broncho pneumonia. (8) Postoperative hemorrhage.
(4) Pulmonary embolism. (9) Empyema.
(5) Septicemia, not associated with general peritonitis. (0) Other diseases than above noted.....
(Write in name)

24. Primary cause of death from importance of disease causing death: (Do not fill in.)
(1) (7)
(2) (8)
(3) (9)
(4) (0)
(5) (X)
(6) (Δ)

25. Did primary cause of death exist before operation? (1) Yes. (2) No.

Signature of Investigator.....

FIG. 178 Appendicitis Code

EYE — DIABETES CODE

1. MONTH EXAM. (1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12).

2. A. YR. EXAM. (11) 1929 (12) 1930 (1) 1931 (2) 1932 (3) 1933.
   B. DUR. (4) less than 1 yr. (5) 1 to 1.9 yr. (6) 2 to 2.9 yr. (7) 3 to 4.9 yr. (8) 5 to 9.9 yr. (9) 10 to 15 yr. (10) over 15 yr.

3. A. SEX (12) M. (11) F.
   B. AGE (10) under 10 yr. (1) 10 to 19 yr. (2) 20 to 29 yr. (3) 30 to 39 yr. (4) 40 to 49 yr. (5) 50 to 59 yr. (6) 60 to 69 yr. (7) 70 to 80 yr. (8) over 80 yr.

4. COMPLICATIONS (1) Coma this adm. (2) Coma at prev. adm. (3) More than 2 comas (9) Tbc—old or healed (10) Tbc—suspic (11) Tbc—active.
   (4) Gangrene (5) Neuritis—Tox. (6) Neuritis—Deg. (7) Neuritis—Cir. (8) Neuritis—Hygl.

5. A. (1) Syph. pres. (2) Syph. abs. (3) Ang - Cor. (4) Calc aorta pres. (5) Calc legs pres. (6) Calc legs abs.
   B. B. M. (7) under —10 (8) —10 to 0 (9) 0 to + 10 (10) over +10.

6. A. HEART (1) P. N. (2) X. N. (3) P. L. (4) X. L. (5) P. N.-X. L. (6) P. L.-X. N.
   B. RADIAL VESSELS CLIN. (7) #0 (8) #1 (9) #2 (10) #3 (11) #4 (12) unrec.

7. A. B. P.—SYST. (exam. day) (1) less than 120 (2) 120 - 139 (3) 140 - 149 (4) 150 - 159 (5) 160 - 169 (6) 170 - 189 (7) 190 - 210 (8) over 210.
   B. B. P.—SYST. (max.) (9) under 140 (10) 140 - 159 (11) 160 - 180 (12) over 180.

8. A. B. P.—DIAST. (exam. day) (1) less than 60 (2) 60 - 79 (3) 80 - 89 (4) 90 - 99 (5) 100 - 109 (6) 110 - 130 (7) over 130.
   B. B. P.—DIAST. (max.) (8) under 80 (9) 80 - 89 (10) 90 - 99 (11) 100 - 110 (12) over 110.

9. A. BLOOD SUGAR (max. fast.) (1) below 140 (2) 140 - 169 (3) 170 - 199 (4) 200 - 249 (5) 250 - 299 (6) 300 - 400 (7) over 400.
   B. BLOOD SUGAR (min.) (8) below 50 (9) 50 - 59 (10) 60 - 69 (11) 70 - 79.

10. A. BLOOD SUGAR (max. non-fast.) (1) below 170 (2) 170 - 199 (3) 200 - 249 (4) 250 - 299 (5) 300 - 400 (6) above 400.
    B. N. P. N. (7) below 35 (8) 35 - 39 (9) 40 - 44 (10) 45 - 50 (11) above 50.

11. A. PHOS. (1) below 2.5 (2) 2.5 - 2.9 (3) 3.0 - 3.4 (4) 3.5 - 3.9 (5) 4.0 - 4.4 (6) 4.5 - 5.0 (7) above 5.0.
    B. CA. (8) below 9.0 (9) 9.0 - 9.9 (10) 10 - 10.9 (11) 11 - 12 (12) above 12.

12. A. CHOL. (within 3 mos. of exam day) (1) below 100 (2) 100 - 199 (3) 200 - 229 (4) 230 - 259 (5) 260 - 299 (6) 300 - 349 (7) 350 - 400 (8) above 400.
    B. (9) Chol. above 230 prior to exam. (10) Chol. above 300 prior to exam. (11) Chol. above 230 since exam. (12) Chol. above 300 since exam.

13. A. (1) Patients with more than 1 determin. (3 mos. apart) (2) Chol. increasing but still below 230 on exam. day (3) Chol. increasing and over 230 on exam. day
    (4) Chol. decreasing but still above 230 on exam. day (5) Chol. decreasing and under 230 on exam. day.
    B. PHTH. (7) 20% or less (8) 20 - 40% (9) over 40% (10) less than 15% in 15' (11) 15% or more in 15'.

14. A. ALB. (1) abs. or S. P. T. (2) V. S. T. (3) S. T., T., or L. T.
    B. SUGAR ADM. (4) 0.3% or less (5) 0.3% - 0.9% (6) 1% - 2.9% (7) 3% - 5% (8) over 5%
    C. SUGAR DISCH. (9) 0.3% or less (10) 0.3% to 1% (11) over 1%.

15. INSULIN A. AMT. (1) none (2) 1 - 14 (3) 15 - 29 (4) 30 - 50 (5) over 50. C. REACTIONS (12) pres.
    B. DUR. (6) adm. or less than 1 mo. (7) 1 - 11 mos. (8) 1 - 2.9 yrs. (9) 3 - 4.9 yrs. (10) 5 - 10 yrs. (11) over 10 yrs.

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16. RIGHT EYE. REF. CHGS. (1) H. A. (2) M. A. (3) Mix. (4) Emm. (5) unrec. (6) Trans. EYELIDS (7) Xanth. (8) Ptosis (9) Bleph (10) Hord. (11) Conj.

17. VISUAL ACUITY (1) unrec. (2) 6/5 or better (3) 6/6 (4) 6/7 or 6/10 (5) 6/12 (6) 6/15 or 6/20 (7) 6/30 or 6/60 (8) less than 6/60.

18. PUPIL and IRIS (1) Irreg. (2) A. R. (3) No response (4) Slug. (5) PPM (6) Depig. (7) Colob. (8) Active Iritis (9) Quiet Iritis (10) Shallow chamb.

19. CORNEA (1) Imb. (2) Stahli (3) Arcus (4) Opac. (5) Vessels (6) Deposits (7) Amorph. (8) Beaten-silver (9) Pig. (10) Wrinkles—few (11) Wrinkles—many.

20. LENS—ANT. CORT. (1) Chol. (2) Dots (3) Floc. (4) Lam. (5) Wdgs. & (or) Spokes (6) Fis. (7) Vac. (8) Eq.
    ANT. CAP. (10) Des. (11) Pig. i. (12) Pig. c.

21. LENS—SENILE NUC. (1) Lin. Rid. (2) Dots (3) Prot. (4) Sl. Scl. (5) Mod. Scl.
    EMBRY NUC. (6) Clus. (7) Dust.

22. LENS—POST. CORT. (1) Chol. (2) Dots (3) Wdgs. & (or) Spokes (4) Lam. (5) Fis. (6) Vac.
    MISC. (7) Aphak. (8) Coron. (9) Memb. (11) Complic.

23. VITREOUS (1) Aster. hyal. (2) Opac. - fine (3) Opac. - coarse - few (4) Opac - coarse - many (5) Ret. Prolif. (6) Blood.

24. FUNDUS—OPTIC DISC (1) Atrop. (2) Opaq. N. F. (3) Glauc. (4) Edema (5) Conus. (6) Fundus not visible (7) Drusens in fundus
    (8) Degen. and pigment. (9) Chol. cryst. in fundus (10) Retinal folds (11) Detached retina (12) Cap. bed.

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25. FUNDUS VESSELS. A. ART. (0) #0 (1) #1 (2) #2 (3) #3 (4) #4. B. VEINS (5) #0 (6) #1 (7) #2 (8) #3 (9) #4.

26. FUNDUS. A. HEM. (1) Deep - + (2) Deep - ++ (3) Deep - +++ (4) Super. - + (5) Super. - ++ and +++ (6) Pre-ret.
    B. EXUD. (7) Diab. + (8) Diab. ++ (9) Diab. +++ (10) Renal + (11) Renal ++ and +++.

27. FIELDS (1) Periph. field not taken (2) Blind spot not taken (3) Hom. hemianop. (4) Concen. contract. (5) Sect. or other periph. defect.
    (6) Central scot. demonstrated (7) Central scot. probably pres. but not demonstrated (8) Para-central scot. and ring scot.
    (9) Hom. hemianop. scot. (10) Color blind (11) Toxic ambly. (12) Blind spots larger than 13 x 16.

28. TENSION (1) not taken (2) under 13 (3) 13 - 14 (4) 15 - 16 (5) 17 - 18 (6) 19 - 22 (7) 23 - 25 (8) 26 - 30 (9) 31 - 40 (10) over 40 (11) diag. of glaucoma.

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29. LEFT EYE. REF. CHGS. (1) H. A. (2) M. A. (3) Mix. (4) Emm. (5) unrec. (6) Trans. EYELIDS (7) Xanth. (8) Ptosis (9) Bleph (10) Hord. (11) Conj.

30. VISUAL ACUITY (1) unrec. (2) 6/5 or better (3) 6/6 (4) 6/7 or 6/10 (5) 6/12 (6) 6/15 or 6/20 (7) 6/30 or 6/60 (8) less than 6/60.

31. PUPIL and IRIS (1) Irreg. (2) A. R. (3) No response (4) Slug. (5) PPM (6) Depig. (7) Colob. (8) Active Iritis (9) Quiet Iritis (10) Shallow chamb.

32. CORNEA (1) Imb. (2) Stahli. (3) Arcus (4) Opac. (5) Vessels (6) Deposits (7) Amorph. (8) Beaten-silver (9) Pig. (10) Wrinkles—few (11) Wrinkles—many.

33. LENS—ANT. CORT. (1) Chol. (2) Dots (3) Floc. (4) Lam. (5) Wdgs. & (or) Spokes (6) Fis. (7) Vac. (8) Eq.
    ANT. CAP. (10) Des. (11) Pig. i. (12) Pig. c.

34. LENS—SENILE NUC. (1) Lin. Rid. (2) Dots (3) Prot. (4) Sl. Scl. (5) Mod. Scl.
    EMBRY. NUC. (6) Clus. (7) Dust.

35. LENS—POST. CORT. (1) Chol. (2) Dots (3) Wdgs. & (or) Spokes (4) Lam. (5) Fis. (6) Vac.
    MISC. (7) Aphak. (8) Coron. (9) Memb. (11) Complic.

36. VITREOUS (1) Aster. hyal. (2) Opac. - fine (3) Opac. - coarse - few (4) Opac - coarse - many (5) Ret. Prolif. (6) Blood.

37. FUNDUS—OPTIC DISC (1) Atrop. (2) Opaq. N. F. (3) Glauc. (4) Edema (5) Conus. (6) Fundus not visible (7) Drusens in fundus
    (8) Degen. and pigment. (9) Chol. cryst. in fundus (10) Retinal folds (11) Detached retina (12) Cap. bed.

38. FUNDUS VESSELS. A. ART (0) #0 (1) #1 (2) #2 (3) #3 (4) #4. B. VEINS (5) #0 (6) #1 (7) #2 (8) #3 (9) #4.

39. FUNDUS. A. HEM. (1) Deep - + (2) Deep - ++ (3) Deep - +++ (4) Super. - + (5) Super. - ++ and +++ (6) Pre-ret.
    B. EXUD. (7) Diab. + (8) Diab. ++ (9) Diab. +++ (10) Renal + (11) Renal ++ and +++.

40. FIELDS (1) Periph. field not taken (2) Blind spot not taken (3) Hom. hemianop. (4) Concen. contract. (5) Sect. or other periph. defect.
    (6) Central scot. demonstrated (7) Central scot. probably pres. but not demonstrated (8) Para-central scot. and ring scot.
    (9) Hom. hemianop. scot. (10) Color blind (11) Toxic ambly. (12) Blind spots larger than 13 x 16.

41. TENSION (1) not taken (2) under 13 (3) 13 - 14 (4) 15 - 16 (5) 17 - 18 (6) 19 - 22 (7) 23 - 25 (8) 26 - 30 (9) 31 - 40 (10) over 40 (11) diag. of glaucoma.

---

42. MUSCLES. TROP. (1) Paraly. strab. (2) Comit. strab. PHOR. (3) Vert. not recor. (4) Vert. of over 1 deg.
    DUCT. (5) Duct. not recor. (6) Over 7 deg. base in (7) 2:1 ratio or better. ACCOM. (8) Not recor. (9) Possibly paresis of. NYSTAG. (10) Pres.

43. (1) Dead (2) Alive (3) Unknown (4) Autopsy (5) Died 1929 (6) 1930 (7) 1931 (8) 1932 (9) 1933.

44, 45. DIAGNOSIS CODE

Carc. or sarc. (any location) (00)

Blood dis. (01) Anemia - sec.
(02) Anemia - prim.
(03) Polycyth.
(04) Leuk.
(05) other blood dis.

Liver and G. B. dis. (31) Jaundice
(32) G. B. disease
(33) Cirrhosis
(34) other liver dis.

C. N. S. dis. (61) Psychoneurosis
(62) Brain tumor
(63) Hemorrhage
(64) other C. N. S. dis.

Respir. dis. (11) Lung abscess
(12) Asthma
(13) Bronchitis
(14) Pneumonia
(15) other resp. dis.

Cardio-vasc. dis. (41) Art.-Scl. Heart dis.
(42) Hyper. Heart dis.
(43) Rheum. Heart dis.
(44) Generalized A. T. S.
(45) Aortitis
(46) other Card.-vasc. dis.

Endocrine dis. (71) Thyroid
(72) Parathyroid
(73) Pituitary
(74) Gonads
(75) other endo. dis.

Gastro-intest. dis. (21) Gastric ulcer (or duod)
(22) Colitis
(23) Constipation
(24) other G. I. dis.

Kidney dis. (51) Chronic nephritis
(52) Acute nephritis
(53) Cystitis or Pyelitis
(54) other kid. dis.

Metab. dis. (81) Arthritis
(82) Obesity
(83) Diabetes
(84) Vitam. defic.

Bone dis. (91)

FIG 179

Eye-Diabetes Code

of their numerous tabulations have not as yet been published, but they have been kind enough to accede to the request for a representative table for this chapter.

TABLE III

RETINAL HEMORRHAGES (DEEP TYPE)

	Diabetics			Non-Diabetics		
Age Group	*Fundi Visible*	*Deep Hemor.*	*Per Cent*	*Fundi Visible*	*Deep Hemor.*	*Per Cent*
1-10	130	0	—			
10-19	464	4	0.8			
20-29	274	10	3.6	20	0	—
30-39	315	17	5.4	129	6	4.6
40-49	512	75	14.6	305	8	2.6
50-59	1001	282	28.1	229	14	6.1
60-69	957	270	28.2	164	6	3.6
70 and up	240	72	30.0	54	0	—
Total	3893	730	18.7	901	34	3.8
Fundi not visible	108			13		
Eyes examined	4001			914		

Example 4, Acute Empyema

Another important study in which punched cards were almost indispensable is that of Dr. Edwin A. Locke* on Acute Empyema. The cases were taken from the records of the Boston City Hospital. The aim of the study is clearly set forth in the following quotation from Dr. Locke's paper:

"Our interest in this study has been primarily to determine any relation which may exist between the type of organism and the nature and course of the disease. Does the biological classification of pneumococci, for example, give us any indications by which we may predict the probable outcome of the pleural infection more accurately? In other words, does an accurate knowledge of the bacteriology of a given case afford any practical clinical assistance in treating the patient? We believe we can present evidence which justifies an affirmative answer. It seems possible to a considerable degree to correlate certain features of the clinical picture, the course of the disease and the response to treatment with the type of organism causing the pleural infection.

"In the following table 478 cases are grouped according to the primary disease and the organism present in the chest fluid. The fatality rate with respect to the type of organism found in the pleural fluid varies greatly and probably significantly. Type I has a much lower rate than any of the other groups, namely, 11 per cent for 202 cases.

"Sixty-two of the 478 cases in our series were not treated surgically and a close analysis of this group yields some interesting results. When separated according to the organism found in the chest exudate the various groups present a surprisingly uniform and very high death rate.

"The results of surgical drainage in the remaining 416 cases as given in Table V are extremely interesting and obviously furnish a much more exact idea of the prognosis in empyema with surgical drainage than do the figures

* Locke, Edwin A., M.D., Acute Empyema, New England Medical Journal, Vol. 203, No. 9, Aug. 28, 1930.

TABLE IV

EMPYEMA INCIDENCE AND CASE FATALITY

Organism	*Lobar Pneumonia*		*Post Pneumonia*		*Broncho-pneumonia*		*Unknown*		*Totals*		*Fatality*
	No. Cases	No. Died	No. Cases	No. Died	No. Cases	No. Died	No. Cases	No. Died	No. Cases	No. Died	Per Cent
Pneumococci, Type I	126	12	66	6	8	4	2	1	202	23	11
" " II	18	6	5	1	2	2	0	0	25	9	36
" " III	8	4	3	0	2	1	0	0	13	5	38
" " IV	23	6	10	3	3	2	1	0	37	11	30
" Not typed	7	2	0	0	0	0	1	0	8	2	25
Total Pneumococci	182	30	84	10	15	9	4	1	285	50	18
Hem. Strep.	25	8	43	7	20	15	0	0	88	30	34
Non-Hem. Strep.	4	0	12	1	2	0	1	0	19	1	5
Staphy.	11	3	10	1	4	2	0	0	25	6	24
Undetermined	23	9	33	11	5	4	0	0	61	24	39
Totals	245	50	182	30	46	30	5	1	478	111	23.2

of the death rate shown in Table IV. One is immediately struck with the much lower death rate as well as the greater uniformity in this rate among the various types of infection."

TABLE V

DEATH RATE WITH AND WITHOUT PERMANENT DRAINAGE

Organism	Cases Without Operation			Operated Cases		
	No. Cases	No. Died	Per Cent	No. Cases	No. Died	Per Cent
Pneumococci, Type I	10	4	40	192	19	10
" " II	6	5	83	19	4	21
" " III	3	3	100	10	2	20
" " IV	6	4	67	31	7	23
" Undetermined	1	1	100	7	1	14
Totals	26	17	65	259	33	13
Hem. Strep.	12	12	100	76	18	24
Non-Hem. Strep.	2	1	50	17	0	0
Staphy. Aur.	2	2	100	23	3	13
Undetermined	20	12	60	41	12	29
Totals	62	44	73	416	66	16

Hospital Records in General

One drawback in the study of hospital records is that they are becoming more detailed and consequently more bulky. If a clinician wishes to abstract certain information about a series of cases he must read through a mass of material in order to find it. Later on some other clinician interested in the same disease will wade through the same material to gather other data. This is very wasteful of the time of the hospital staff. If a large number of factors for each disease could be taken from the records and put upon punched cards, then many studies not otherwise possible would be made. There is enough reliable material in a case record of a well-administered hospital to warrant the extra initial expenditure of time. In fact several hospitals in the country are beginning to make their records available for careful study. There have been, however, but few attempts to keep records in such shape that studies can be made continuously from them as records increase in number. One such at-

tempt has been made by Dr. Jacob Lerman, Director of the Thyroid Clinic and of the Metabolism Laboratory at the Massuchusetts General Hospital, who is somewhat of a pioneer in clinical statistics. For five or six years he has kept his records on punched cards, transferring to them new records as they came along, and has built up an original research library (punched cards) of thyroid conditions which so far as we know cannot be duplicated anywhere. This procedure would be practical wherever records tend to become bulky —as in psychiatric case histories, social welfare case records, criminological case histories, etc., provided the material is of such a nature that it can be studied profitably. A recent publication of some 1100 pages, size 8 x 10½ describes five case histories of criminals; they may be of some value to creators of mystery stories or even of great help to the artists of Hollywood but hardly worthy of analytical treatment.

PART VII

Applications in Legal Research

PART VII

Applications in Legal Research

CHAPTER I

Judicial Statistics in General

By
CHARLES U. SAMENOW
Attorney-at-Law, formerly Instructor at the Yale School of Law

CONSTANTLY increasing congestion in the courts with its attendant problems has focused attention upon the need of quantitative measures of court activity. Although judicial statistics have been collected regularly in some places, intermittently in others, for more than fifty years, not until the last decade have exhaustive statistical observations of courts and court processes and extensive dissections of court cases been made.* In 1927 and 1928 Dean Charles E. Clark, then professor at the Yale School of Law, conducted a series of studies of judicial statistics in various Connecticut and Massachusetts courts.** In 1929 a grant from one of the foundations permitted the extension of these studies to include more courts and longer periods of time. Civil statistics were considered first. The Connecticut study was geared to pick up data which had not previously been sought in any large survey of this sort. Practically an uncharted field of statistics was being explored. The charts and data sheets previously used were not capable of handling the wealth of material sought for two reasons; first, the cases were too numerous to be tabulated manually; second, the content of the final tabulations was unknown since the investigators could not predict what the cases would show. A flexible statistical system was a necessity, a system which would allow the worker to pick up all information which seemed of any importance, record this information easily and tabulate it with a minimum of manual work. Such a system was found in the Hollerith machines.

Data sheets were printed containing all relevant information on the cases studied, which might be picked up by the field worker who, after identifying the case on the sheet, had only to check a code number opposite the proper

* Examples of judicial statistics officially collected for a long period of time appear in the Annual Reports of the Attorney General of the United States and in the Annual Reports of the Secretary of State of Ohio.
Examples of special studies in judicial statistics are: Sutherland, Federal Police Courts (1926) 11 Mass. Law Quarterly No. 5, Page 43; Illinois Crime Survey (1929); Missouri Crime Survey (1926); Cleveland Crime Survey (1922).

** Reports on the results of these studies may be found in: Clark, Fact Research in Law Administration (1928) 2 Conn. Bar Journal 211, 1 Miss. Law Journal 324; Clark, Should Pleadings Be Filed Promptly? (1929) 3 Conn. Bar Journal 69; Clark and O'Connell, The Hartford Small Claims Court (1929) 3 Conn. Bar Journal 123; Clark, Some of the Facts of Law Administration in Connecticut (1929) 3 Conn. Bar Journal 161.

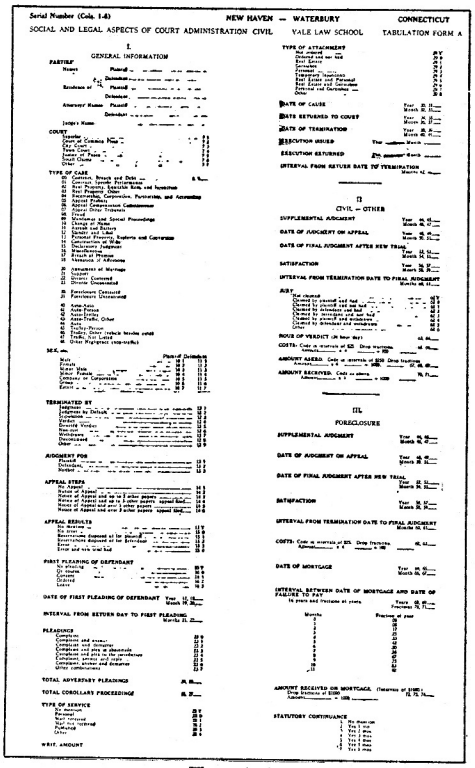


FIG. 180

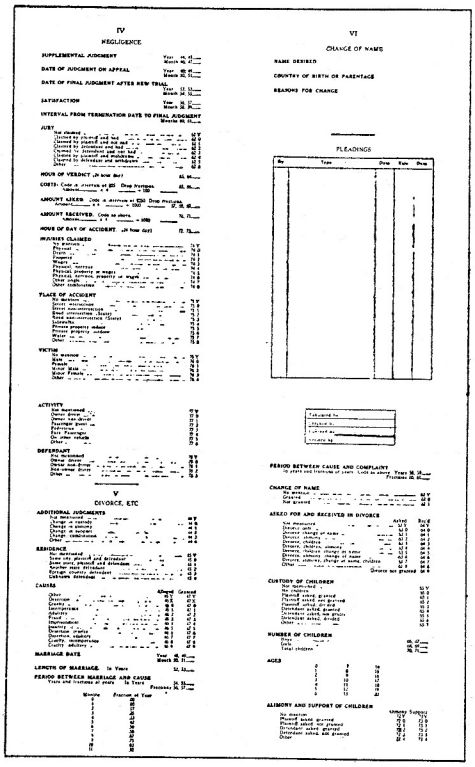


FIG. 181

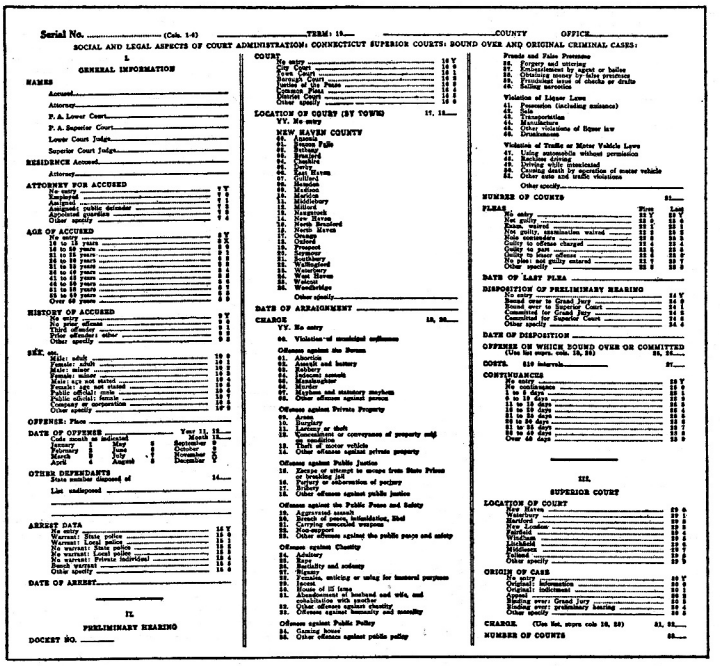
item. The sheet used in the study of civil cases in the Connecticut Superior Courts is shown above.* (Figs. 180 and 181.) Once these sheets were checked, the process was purely mechanical and gratifyingly accurate. A wealth of combinations was available in the tabulation of the data on the sheets. Some of the material turned out to have little intrinsic value; other material, the value of which appeared doubtful at the outset, showed up very profitably.** The versatility of the statistical system permitted of all sorts of statistical experimentation and assisted greatly in evaluation of the items selected for statistical investigation.

The Hollerith statistical system was employed subsequently in the study of criminal cases conducted by the Yale School of Law in the Connecticut Superior Courts. The form used in that study is reproduced here. (Figs. 182 and 183.)

In the spring of 1930 a committee headed by Dean Clark was appointed by the National Commission on Law Observance and Enforcement to conduct a study of law administration in the federal courts. This study was to follow the lines of the state court projects. Currently with this study a subcommittee of the Commission was making a general analysis of judicial statistics then

* A slightly condensed form was used for the last four years of the civil case study.

** The results of the Connecticut study which covers a fourteen year period are being prepared for publication. Some of the material has already appeared in law journal articles: Shulman and Thompson, Mortgage Foreclosures in Superior Court for New Haven County, at New Haven, 1929-1932 (Oct. 1933) Bull. N. H. County Bar Association 4; Clark and Shulman, Jury Trial in Civil Cases—A Study in Judicial Administration (1934) 43 Yale Law Journal 867. See also Clark and King, Statistical Method in Legal Research (1930) 5 Yale Sci Mag. (No. 1) 15.



Serial No. ..... (Cols. 1-6) TERM: 19— COUNTY OFFICE

SOCIAL AND LEGAL ASPECTS OF COURT ADMINISTRATION: CONNECTICUT SUPERIOR COURTS: BOUND OVER AND ORIGINAL CRIMINAL CASES:

I.

GENERAL INFORMATION

NAMES

Accused

Attorney

P. A. Lower Court

P. A. Superior Court

Lower Court Judge

Superior Court Judge

RESIDENCE Accused

Attorney

ATTORNEY FOR ACCUSED

No entry 7 Y
Employed 7 1
Appointed 7 2
Assigned public defender 7 3
Appointed guardian 7 4
Other specify 7 4

AGE OF ACCUSED

No entry 8 Y
16 to 17 years 8 0
18 to 20 years 8 1
21 to 25 years 8 2
26 to 30 years 8 3
31 to 35 years 8 4
36 to 40 years 8 5
41 to 45 years 8 6
46 to 50 years 8 7
51 to 55 years 8 8
56 to 60 years 8 9
Over 60 years 8 0

HISTORY OF ACCUSED

No entry 9 Y
No prior offense 9 0
Third offender 9 1
Other specify 9 2

SEX, etc.

Male: adult 10 0
Male: youth 10 1
Male: minor 10 2
Female: minor 10 3
Male: sex not stated 10 4
Female: adult, sex not stated 10 5
Public official: male 10 6
Public official: female 10 7
Company or corporation 10 8
Other specify 10 9

OFFENSE: Place

DATE OF OFFENSE Year 11, 12—
Code month as indicated Month 13—

January	1	May	5
February	2	June	6
March	3	July	7
April	4	August	8
		September	9
		October	0
		November	X
		December	Y

OTHER DEFENDANTS

State number disposed of 14—

List undisposed

ARREST DATA

No entry 15 Y
Warrant: State police 15 0
Warrant: Local police 15 1
No warrant: State police 15 2
No warrant: Local police 15 3
Search warrant (evidence) 15 4
Other specify 15 9

DATE OF ARREST

II.

PRELIMINARY HEARING

DOCKET NO.

COURT

No entry 16 Y
City Court 16 0
Town Court 16 1
Borough Court 16 2
Justice of the Peace 16 3
Police Court 16 4
Common Court 16 5
Other specify 16 9

LOCATION OF COURT (BY TOWN) 17, 18—
YY. No entry

NEW HAVEN COUNTY

01. Ansonia
02. Beacon Falls
03. Bethany
04. Branford
05. Cheshire
06. Derby
07. East Haven
08. Guilford
09. Hamden
10. Madison
11. Meriden
12. Middlebury
13. Milford
14. Naugatuck
15. New Haven
16. North Branford
17. North Haven
18. Orange
19. Oxford
20. Prospect
21. Seymour
22. Southbury
23. Wallingford
24. Waterbury
25. West Haven
26. Wolcott
27. Woodbridge

Other specify

DATE OF ARRAIGNMENT

CHARGE 19, 20—
YY. No entry

00. Violation of municipal ordinance

Offenses against the Person

01. Abortion
02. Assault and battery
03. Robbery
04. Indecent assault
05. Manslaughter
06. Murder
07. Rape and statutory mayhem
08. Other offenses against person

Offenses against Private Property

09. Arson
10. Burglary
11. Larceny or theft
12. Receiving stolen or conveyance of property subj to recognition
13. Theft of motor vehicle
14. Other offenses against private property

Offenses against Public Justice

15. Escape or attempt to escape from State Prison or from jail
16. Perjury or subornation of perjury
17. Bribery
18. Other offenses against public justice

Offenses against the Public Peace and Safety

19. Aggravated assault
20. Breach of peace, intimidation, libel
21. Carrying concealed weapon
22. Intercourse
23. Other offenses against the public peace and safety

Offenses against Chastity

24. Adultery
25. Bigamy
26. Bestiality and sodomy
27. Incest
28. Lewdness, enticing or using for immoral purposes
29. Incest of ill fame
30. Desertion of husband and wife, and cohabitation with another
31. Other offenses against chastity

Offenses against Public Policy

32. Gaming house
33. Other offenses against public policy

Frauds and False Pretenses

34. Forgery and uttering
35. Embezzlement, agent or bailee
36. Obtaining money by false pretenses
37. Fraudulent issue of checks or drafts
38. Selling nuisance

Violation of Liquor Laws

41. Possession (including nuisance)
42. Sale
43. Transportation
44. Manufacture
45. Other violations of liquor law
46. Drunkenness

Violation of Traffic or Motor Vehicle Laws

47. Using automobile without permission
48. Reckless driving
49. Driving while intoxicated
50. Causing death by operation of motor vehicle
51. Other auto and traffic violations

Other specify

NUMBER OF COUNTS 21—

PLEAS

	First	Last
No entry	22 Y	23 Y
Not guilty	22 0	23 0
Plea, waived	22 1	23 1
Nolo contendere waived	22 2	23 2
Nolo contendere	22 3	23 3
Guilty to offense charged	22 4	23 4
Guilty to part	22 5	23 5
Guilty to lesser offense	22 6	23 6
No plea: not guilty entered	22 7	23 7
Other specify	22 9	23 9

DATE OF LAST PLEA

DISPOSITION OF PRELIMINARY HEARING

No entry 24 Y
Bound over to Grand Jury 24 0
Bound over to Superior Court 24 1
Committed for Grand Jury 24 2
Committed for Superior Court 24 3
Other specify 24 4

DATE OF DISPOSITION

OFFENSE ON WHICH BOUND OVER OR COMMITTED (Use last num. cols. 18, 20) 25, 26—

COSTS. $10 intervals 27—

CONTINUANCES

No entry 28 Y
No continuance 28 0
1 to 5 days 28 1
6 to 10 days 28 2
11 to 15 days 28 3
16 to 20 days 28 4
21 to 30 days 28 5
31 to 45 days 28 6
46 to 60 days 28 7
61 to 90 days 28 8
Over 90 days 28 9

III.

SUPERIOR COURT

LOCATION OF COURT

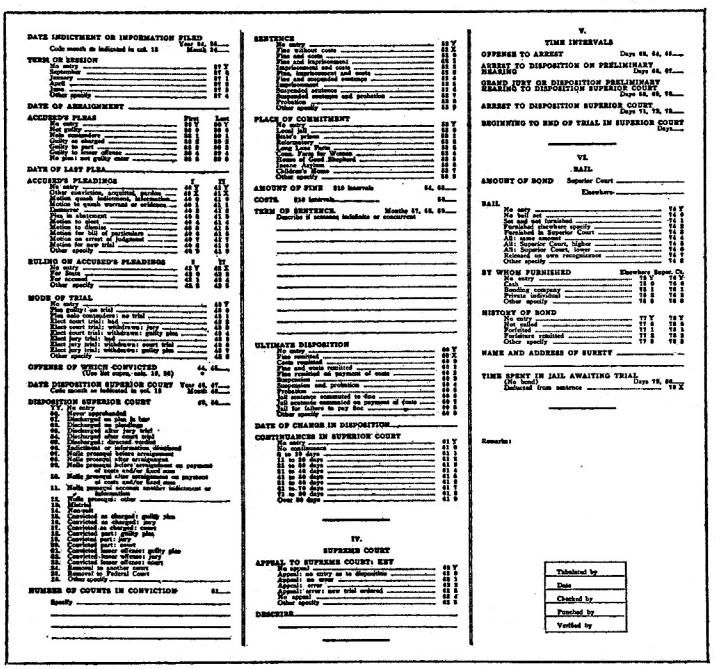
New Haven 29 0
Waterbury 29 1
Hartford 29 2
New London 29 3
Litchfield 29 4
Middlesex 29 5
Tolland 29 6
Other specify

ORIGIN OF CASE

No entry 30 Y
Original: information 30 0
Original: indictment 30 1
Appeal 30 2
Binding over: Grand Jury 30 3
Binding over: preliminary hearing 30 4
Other specify 30 9

CHARGE. (Use last num. cols 18, 20) 31, 32—

NUMBER OF COUNTS 33—



DATE INDICTMENT OR INFORMATION FILED Year 34, 35—
Code month as indicated in col. 13 Month 36—

TERM OF SESSION

No entry 37 Y
September 37 0
January 37 1
June 37 2
Other specify 37 9

DATE OF ARRAIGNMENT

ACCUSED'S PLEAS

	First	Last
No entry	38 Y	39 Y
Not guilty	38 0	39 0
Nolo contendere	38 1	39 1
Guilty to part	38 2	39 2
Guilty to lesser offense	38 3	39 3
No plea: not guilty enter	38 4	39 4

DATE OF LAST PLEA

ACCUSED'S PLEADINGS

	I.	II.
No entry	40 Y	41 Y
Other elections, acquittal, pardon, etc.	40 0	41 0
Motion quash indictment, information	40 1	41 1
Motion to quash warrant or evidence, etc.	40 2	41 2
Demurrer	40 3	41 3
Plea in abatement	40 4	41 4
Motion to plead	40 5	41 5
Motion to change	40 6	41 6
Motion for bill of particulars	40 7	41 7
Motion for arrest of judgment	40 8	41 8
Other specify	40 9	41 9

RULING ON ACCUSED'S PLEADINGS

	I.	II.
No entry	42 Y	43 X
For accused	42 0	43 0
For state	42 1	43 1
Other specify	42 9	43 9

MODE OF TRIAL

No entry 44 Y
Plea guilty: no trial 44 0
Plea nolo contendere: no trial 44 1
Elect court trial: trial 44 2
Elect court trial: withdrawn: jury 44 3
Elect court trial: withdrawn: guilty plea 44 4
Elect jury trial: trial 44 5
Elect jury trial: withdrawn: court trial 44 6
Elect jury trial: withdrawn: guilty plea 44 7
Other specify 44 9

OFFENSE OF WHICH CONVICTED 44, 45—
(Use last num. cols. 18, 20)

DATE DISPOSITION SUPERIOR COURT Year 46, 47—
Code month as indicated in col. 13 Month 48—

DISPOSITION SUPERIOR COURT 49, 50—

YY. No entry
00. Never apprehended
01. Discharged on plea in bar
02. Discharged on pleadings
03. Discharged after jury trial
04. Discharged: other court trial
05. Discharged: nolle prosequi
06. Discharged of information dismissed
07. Nolle prosequi before arraignment
08. Nolle prosequi after arraignment
09. Nolle prosequi before arraignment on payment of court costs
10. Nolle prosequi after arraignment on payment of court costs
11. Nolle prosequi warrant number indictment or information
12. Other disposed: other
13. Mistrial
14. Remanded
15. Convicted on charged: guilty plea
16. Convicted on charged: jury
17. Convicted on charged: court
18. Convicted part: guilty plea
19. Convicted part: jury
20. Convicted part: court
21. Convicted lesser offense: guilty plea
22. Convicted lesser offense: jury
23. Convicted lesser offense: court
24. Removed to Federal Court
25. Other specify

NUMBER OF COUNTS IN CONVICTION 51—

Specify

SENTENCE

No entry 52 Y
Fine and costs 52 X
Fine and imprisonment 52 1
Imprisonment and costs 52 2
Fine, imprisonment and costs 52 3
Fine and probation 52 4
Suspended sentence 52 5
Suspended sentence and probation 52 6
Probation 52 7
Other specify 52 9

PLACE OF COMMITMENT

Local jail 53 Y
State's prison 53 0
Reformatory 53 1
Federal Prison 53 2
Conn. Farm for Women 53 3
Home of Good Shepherd 53 4
Juvenile Court 53 5
Children's Home 53 6
Other specify 53 9

AMOUNT OF FINE $10 intervals 54, 55—

COSTS. $10 intervals 56—

TERM OF SENTENCE. Months 57, 58, 59—
Describe if sentence indefinite or concurrent

ULTIMATE DISPOSITION

No entry 60 Y
Fine remitted 60 X
Fine paid 60 0
Fine and costs remitted 60 1
Fine remitted on payment of costs 60 2
Imprisonment 60 3
Imprisonment and probation 60 4
Probation 60 5
Jail sentence commuted to fine 60 6
Jail sentence commuted on payment of costs 60 7
Jail for failure to pay fine 60 8
Other specify 60 9

DATE OF CHANGE IN DISPOSITION

CONTINUANCES IN SUPERIOR COURT

No entry 61 Y
1 to 5 days 61 1
6 to 10 days 61 2
11 to 15 days 61 3
16 to 20 days 61 4
21 to 30 days 61 5
31 to 45 days 61 6
46 to 60 days 61 7
61 to 90 days 61 8
Over 90 days 61 9

IV.

SUPREME COURT

APPEAL TO SUPREME COURT: ERT

No entry 62 Y
Appeal: no error as to disposition 62 0
Appeal: no error 62 1
Appeal: error 62 2
Appeal: error; new trial ordered 62 3
Appeal 62 4
Other specify 62 9

DESCRIBE

V.

TIME INTERVALS

OFFENSE TO ARREST Days 63, 64, 65—

ARREST TO DISPOSITION ON PRELIMINARY HEARING Days 66, 67—

GRAND JURY OR DISPOSITION PRELIMINARY HEARING TO DISPOSITION SUPERIOR COURT Days 68, 69, 70—

ARREST TO DISPOSITION SUPERIOR COURT Days 71, 72, 73—

BEGINNING TO END OF TRIAL IN SUPERIOR COURT Days

VI.

BAIL

AMOUNT OF BOND Superior Court

Elsewhere

BAIL

No entry 74 Y
No bail set 74 0
Set and not furnished 74 1
Furnished: elsewhere specify 74 2
Set: bail in Superior Court 74 3
Alt: bail 74 4
Alt: Superior Court, higher 74 5
Alt: Superior Court, lower 74 6
Released on own recognizance 74 7
Other specify

BY WHOM FURNISHED Elsewhere Super. Ct.

No entry	75 Y	76 Y
Cash	75 0	76 0
Bonding company	75 1	76 1
Private individual	75 2	76 2
Other specify	75 9	76 9

HISTORY OF BOND

No entry	77 Y	78 Y
Not called	77 1	78 1
Forfeited	77 2	78 2
Forfeiture remitted	77 3	78 3
Other specify	77 9	78 9

NAME AND ADDRESS OF SURETY

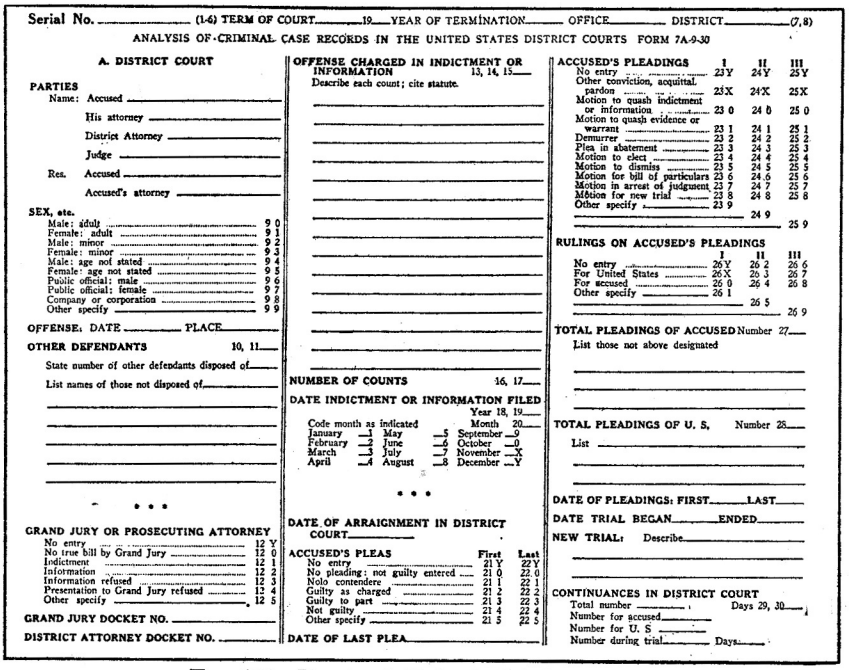
TIME SPENT IN JAIL AWAITING TRIAL (No bond) Days 79, 80—
Deducted from sentence 79 X

Remarks:

Tabulated by
Date
Checked by
Punched by
Verified by

FIG. 182—Front of Connecticut Criminal Form

FIG. 183—Back of Connecticut Criminal Form



Serial No. ____ (1-6) TERM OF COURT____ 19__ YEAR OF TERMINATION____ OFFICE____ DISTRICT____ (7,8)

ANALYSIS OF CRIMINAL CASE RECORDS IN THE UNITED STATES DISTRICT COURTS FORM 7A-9-30

A. DISTRICT COURT

PARTIES
Name: Accused
His attorney
District Attorney
Judge
Res. Accused
Accused's attorney

SEX, etc.
Male: adult 90
Female: adult 91
Male: minor 92
Female: minor 93
Male: age not stated 94
Female: age not stated 95
Public official: male 96
Public official: female 97
Company or corporation 98
Other specify 99

OFFENSE: DATE ____ PLACE____

OTHER DEFENDANTS 10, 11

State number of other defendants disposed of____
List names of those not disposed of____

* * *

GRAND JURY OR PROSECUTING ATTORNEY
No entry 12 Y
No true bill by Grand Jury 12 0
Indictment 12 1
Information 12 2
Information refused 12 3
Presentation to Grand Jury refused 12 4
Other specify 12 5

GRAND JURY DOCKET NO.
DISTRICT ATTORNEY DOCKET NO.

OFFENSE CHARGED IN INDICTMENT OR INFORMATION 13, 14, 15
Describe each count; cite statute.

NUMBER OF COUNTS 16, 17

DATE INDICTMENT OR INFORMATION FILED
Year 18, 19____
Code month as indicated Month 20
January 1 May 5 September 9
February 2 June 6 October 0
March 3 July 7 November X
April 4 August 8 December Y

* * *

DATE OF ARRAIGNMENT IN DISTRICT COURT____

ACCUSED'S PLEAS	First	Last
No entry	21 Y	22 Y
No pleading; not guilty entered	21 0	22 0
Nolo contendere	21 1	22 1
Guilty as charged	21 2	22 2
Guilty to part	21 3	22 3
Not guilty	21 4	22 4
Other specify	21 5	22 5

DATE OF LAST PLEA____

ACCUSED'S PLEADINGS	I	II	III
No entry	23 Y	24 Y	25 Y
Other conviction, acquittal, pardon	23 X	24 X	25 X
Motion to quash indictment or information	23 0	24 0	25 0
Motion to quash evidence or warrant	23 1	24 1	25 1
Demurrer	23 2	24 2	25 2
Plea in abatement	23 3	24 3	25 3
Motion to elect	23 4	24 4	25 4
Motion to dismiss	23 5	24 5	25 5
Motion for bill of particulars	23 6	24 6	25 6
Motion in arrest of judgment	23 7	24 7	25 7
Motion for new trial	23 8	24 8	25 8
Other specify	23 9		
		24 9	
			25 9

RULINGS ON ACCUSED'S PLEADINGS

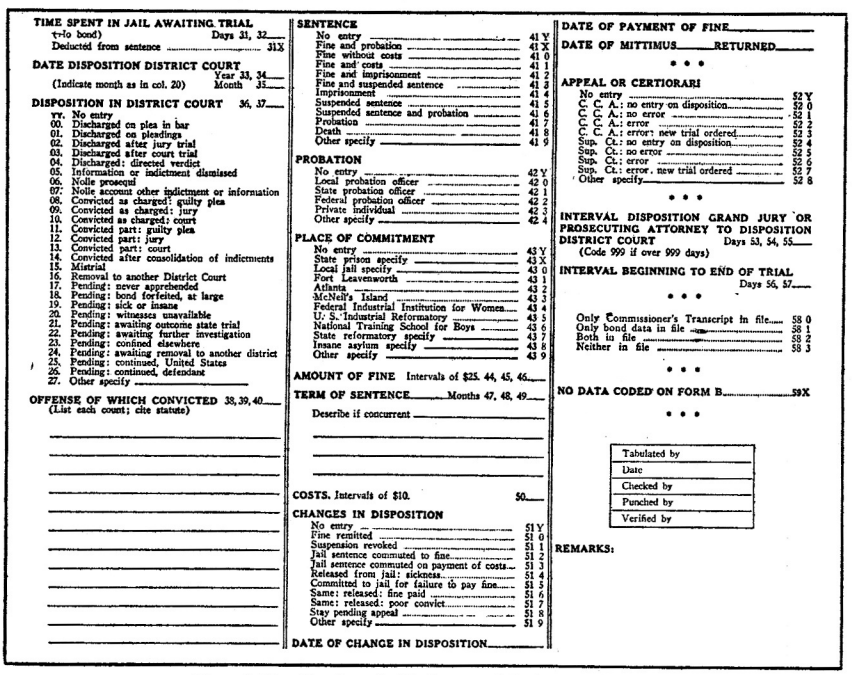
	I	II	III
No entry	26 Y	26 2	26 6
For United States	26 X	26 3	26 7
For accused	26 0	26 4	26 8
Other specify	26 1		
		26 5	
			26 9

TOTAL PLEADINGS OF ACCUSED Number 27
List those not above designated

TOTAL PLEADINGS OF U. S, Number 28
List

DATE OF PLEADINGS: FIRST____ LAST____
DATE TRIAL BEGAN____ ENDED____
NEW TRIAL: Describe

CONTINUANCES IN DISTRICT COURT
Total number Days 29, 30
Number for accused
Number for U. S
Number during trial____ Days____



TIME SPENT IN JAIL AWAITING TRIAL
(No bond) Days 31, 32
Deducted from sentence 33

DATE DISPOSITION DISTRICT COURT
Year 33, 34
(Indicate month as in col. 20) Month 35

DISPOSITION IN DISTRICT COURT 36, 37
YY. No entry
00. Discharged on plea in bar
01. Discharged on pleadings
02. Discharged after jury trial
03. Discharged after court trial
04. Discharged: directed verdict
05. Information or indictment dismissed
06. Nolle prosequi
07. Nolle account other indictment or information
08. Convicted as charged: guilty plea
09. Convicted as charged: jury
10. Convicted as charged: court
11. Convicted part: guilty plea
12. Convicted part: jury
13. Convicted part: court
14. Convicted after consolidation of indictments
15. Mistrial
16. Removal to another District Court
17. Pending: never apprehended
18. Pending: bond forfeited, at large
19. Pending: sick or insane
20. Pending: witnesses unavailable
21. Pending: awaiting outcome state trial
22. Pending: awaiting further investigation
23. Pending: confined elsewhere
24. Pending: awaiting removal to another district
25. Pending: continued, United States
26. Pending: continued, defendant
27. Other specify

OFFENSE OF WHICH CONVICTED 38, 39, 40
(List each count; cite statute)

SENTENCE

No entry	41 Y
Fine and probation	41 X
Fine without costs	41 0
Fine and costs	41 1
Fine and imprisonment	41 2
Fine and suspended sentence	41 3
Imprisonment	41 4
Suspended sentence	41 5
Suspended sentence and probation	41 6
Probation	41 7
Death	41 8
Other specify	41 9

PROBATION

No entry	42 Y
Local probation officer	42 0
State probation officer	42 1
Federal probation officer	42 2
Private individual	42 3
Other specify	42 4

PLACE OF COMMITMENT

No entry	43 Y
State prison specify	43 X
Local jail specify	43 0
Fort Leavenworth	43 1
Atlanta	43 2
McNeil's Island	43 3
Federal Industrial Institution for Women	43 4
U. S. Industrial Reformatory	43 5
National Training School for Boys	43 6
State reformatory specify	43 7
Insane asylum specify	43 8
Other specify	43 9

AMOUNT OF FINE Intervals of $25. 44, 45, 46
TERM OF SENTENCE____ Months 47, 48, 49
Describe if concurrent

COSTS. Intervals of $10. 50

CHANGES IN DISPOSITION

No entry	51 Y
Fine remitted	51 0
Suspension revoked	51 1
Jail sentence commuted to fine	51 2
Jail sentence commuted on payment of costs	51 3
Released from jail: sickness	51 4
Committed to jail for failure to pay fine	51 5
Same: released: fine paid	51 6
Same: released: poor convict	51 7
Stay pending appeal	51 8
Other specify	51 9

DATE OF CHANGE IN DISPOSITION____

DATE OF PAYMENT OF FINE____
DATE OF MITTIMUS____ RETURNED____

* * *

APPEAL OR CERTIORARI

No entry	52 Y
C. C. A.: no entry on disposition	52 0
C. C. A.: no error	52 1
C. C. A.: error	52 2
C. C. A.: error: new trial ordered	52 3
Sup. Ct.: no entry on disposition	52 4
Sup. Ct.: no error	52 5
Sup. Ct.: error	52 6
Sup. Ct.: error, new trial ordered	52 7
Other specify	52 8

* * *

INTERVAL DISPOSITION GRAND JURY OR PROSECUTING ATTORNEY TO DISPOSITION DISTRICT COURT Days 53, 54, 55
(Code 999 if over 999 days)

INTERVAL BEGINNING TO END OF TRIAL Days 56, 57

* * *

Only Commissioner's Transcript in file	58 0
Only bond data in file	58 1
Both in file	58 2
Neither in file	58 3

* * *

NO DATA CODED ON FORM B 59X

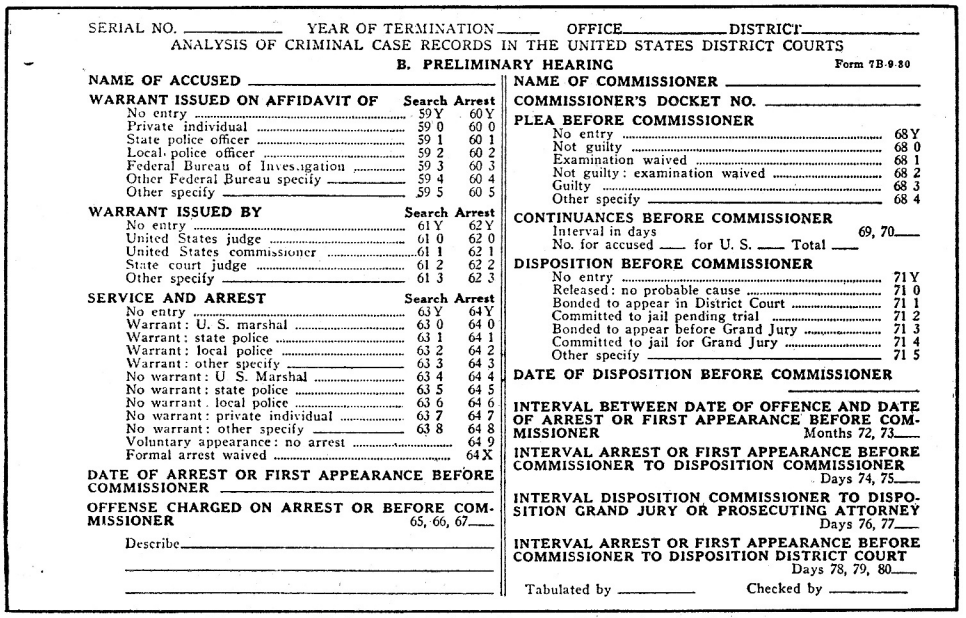
* * *

Tabulated by
Date
Checked by
Punched by
Verified by

REMARKS:

FIG. 184—Front of Federal Criminal Form

FIG. 185—Back of Federal Criminal Form



SERIAL NO. _____ YEAR OF TERMINATION _____ OFFICE _____ DISTRICT _____

ANALYSIS OF CRIMINAL CASE RECORDS IN THE UNITED STATES DISTRICT COURTS

B. PRELIMINARY HEARING Form 7B-9-30

NAME OF ACCUSED _____

WARRANT ISSUED ON AFFIDAVIT OF	Search	Arrest
No entry	59 Y	60 Y
Private individual	59 0	60 0
State police officer	59 1	60 1
Local police officer	59 2	60 2
Federal Bureau of Investigation	59 3	60 3
Other Federal Bureau specify _____	59 4	60 4
Other specify _____	59 5	60 5

WARRANT ISSUED BY	Search	Arrest
No entry	61 Y	62 Y
United States judge	61 0	62 0
United States commissioner	61 1	62 1
State court judge	61 2	62 2
Other specify _____	61 3	62 3

SERVICE AND ARREST	Search	Arrest
No entry	63 Y	64 Y
Warrant: U. S. marshal	63 0	64 0
Warrant: state police	63 1	64 1
Warrant: local police	63 2	64 2
Warrant: other specify _____	63 3	64 3
No warrant: U. S. Marshal	63 4	64 4
No warrant: state police	63 5	64 5
No warrant: local police	63 6	64 6
No warrant: private individual	63 7	64 7
No warrant: other specify _____	63 8	64 8
Voluntary appearance: no arrest		64 9
Formal arrest waived		64 X

DATE OF ARREST OR FIRST APPEARANCE BEFORE COMMISSIONER _____

OFFENSE CHARGED ON ARREST OR BEFORE COMMISSIONER 65, 66, 67____

Describe _____

NAME OF COMMISSIONER _____

COMMISSIONER'S DOCKET NO. _____

PLEA BEFORE COMMISSIONER	
No entry	68 Y
Not guilty	68 0
Examination waived	68 1
Not guilty: examination waived	68 2
Guilty	68 3
Other specify _____	68 4

CONTINUANCES BEFORE COMMISSIONER
Interval in days 69, 70____
No. for accused ____ for U. S. ____ Total ____

DISPOSITION BEFORE COMMISSIONER	
No entry	71 Y
Released: no probable cause	71 0
Bonded to appear in District Court	71 1
Committed to jail pending trial	71 2
Bonded to appear before Grand Jury	71 3
Committed to jail for Grand Jury	71 4
Other specify _____	71 5

DATE OF DISPOSITION BEFORE COMMISSIONER _____

INTERVAL BETWEEN DATE OF OFFENCE AND DATE OF ARREST OR FIRST APPEARANCE BEFORE COMMISSIONER Months 72, 73____

INTERVAL ARREST OR FIRST APPEARANCE BEFORE COMMISSIONER TO DISPOSITION COMMISSIONER Days 74, 75____

INTERVAL DISPOSITION COMMISSIONER TO DISPOSITION GRAND JURY OR PROSECUTING ATTORNEY Days 76, 77____

INTERVAL ARREST OR FIRST APPEARANCE BEFORE COMMISSIONER TO DISPOSITION DISTRICT COURT Days 78, 79, 80____

Tabulated by _____ Checked by _____

FIG. 186—Federal Criminal Form—Preliminary Data

available both in the federal and state courts.* It was hoped that the Federal Court Study would

> "furnish reliable and rather comprehensive information respecting the daily business of the Federal district courts. The data sought (were) in general of three kinds: (1) The kinds and numbers of cases which are coming before the courts, the various statutes or laws which are bringing those cases into these courts, and to some extent the kind of parties which are involved in such cases; (2) the various methods and devices which are employed in the courts by the parties to expedite or delay the trial of these cases, or to try them or otherwise dispose of them; and (3) the various dispositions made of the cases."**

Work began on the criminal cases. After some experimenting, the form illustrated in Figs. 184-185 was devised for criminal cases in the district courts; Fig. 186 for the preliminary phases of those cases.

From the fall of 1930 to July 1, 1931 a staff of 35 field workers visited the offices of the clerks of courts in thirteen districts and from the dockets and files filled out these forms for more than 35,000 cases. In approximately 1200 of the cases, the information was gathered on a condensed card. The large number of cases studied, the number of districts covered and the type of report desired clearly indicated a need for a mechanical tabulating process.

* See Ploscowe, A Critique of Federal Criminal Statistics for The National Commission on Law Observance and Enforcement,; Warner, Survey of Criminal Statistics in the United States for The National Commission on Law Observance and Enforcement; both in Report No. 3 (1931) Report on Criminal Statistics.

** See Progress Report of the Study of the Business of the Federal Courts for The National Commission on Law Observance and Enforcement, page 1.

The punch card system was selected as being best adapted to the needs of the survey.

The same methods were used in the collection and tabulation of some 10,000 civil cases on the form illustrated in Figs. 187-188.

Much of the information collected in the federal court study has already been tabulated. A great deal of it has not been touched but is available as an inexhaustible source for future detailed studies of special matters.[1] The flexibility of the statistical system was well illustrated during the course of the project when a sub-committee of the Commission requested data on juvenile offenders.[2] A special card was set up containing all of the information shown in Figs. 184 to 186 and also the additional items sought. Both cards were filled out and punched together, thereby eliminating the necessity of separate tally sheets, interruption of the worker's regular task, and of a separate manual tabulation. Indeed, without the punch card system, it would not have been possible to have furnished the requested data.

The reports on the study of the federal courts are being published at the time of this writing.[3] An important part of these reports is the "Detailed Tables" so-called which form their bulk. It is safe to say that a great number of these tables would never have been set up had the work to be done manually. The labor, time and expense involved would have been prohibitive.

The adaptability of the punch card system to judicial statistics was demonstrated sufficiently in the federal court study to warrant a recommendation of its use in the office of the Attorney General of the United States for the collection and tabulation of both criminal and civil statistics.[4] The system has also been satisfactorily used in studies of judicial statistics in the state courts of Ohio and West Virginia[5] and in motor vehicle accident[6] studies conducted through the School of Law and Institute of Human Relations of Yale University.

The drive for adequate judicial statistics was carried on at other places as well as at Yale. Some few years after the commencement of the Yale projects a series of studies was initiated in the state courts of Ohio and Maryland by the Institute of Law of The Johns Hopkins University. In some of these studies the tally sheet from which the material was tabulated manually was used; in others, the punch card method.[7] In a series of bulletins and reports the Institute of Law has not only actively encouraged the search into the "treasuries of the trial courts" but has furnished the necessary maps, the data

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[1]See Clark, The Diversity of Citizenship Jurisdiction of the Federal Courts (1933) 19 American Bar Assn. Journal 499; Douglas and Marshall, Bankruptcy Administration: A Factual Study and Some Suggestions (1932) 32 Columbia Law Review 24, 38-42.

[2]See Chapter IV of the Report on The Child Offender in the Federal System of Justice (1931) Report No. 6.

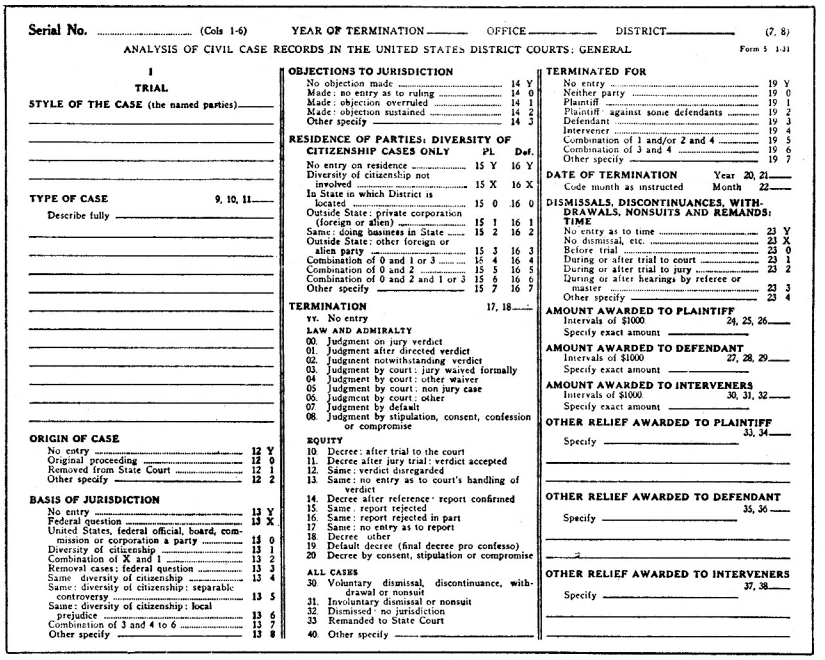
[3]There are two volumes, one on criminal cases, the other on civil. They are published as of May 10, 1934 from the Executive Office of the American Law Institute at Philadelphia. The appendices of these reports reproduce the instructions issued to the field workers on this project, giving detailed directions as to the manner of handling the various forms. Copies of the Manual for Field Workers are also available at the Yale School of Law.

[4]See Report on Criminal Cases (1934) 16; Report on Civil Cases (1934) 21.

[5]The reports of these studies are now being prepared and will be published in the near future. The data cards used are not reproduced here because of their similarity to those of the Connecticut and federal studies.

[6]This project had important sociological aspects. For its method and content the report thereon should be consulted. Report of The Committee to Study Compensation for Automobile Accidents (1932).

[7]EDITOR'S NOTE: See card form Fig. 4 on page 6.



Serial No. ..... (Cols 1-6) YEAR OF TERMINATION ____ OFFICE ____ DISTRICT ____ (7, 8)

ANALYSIS OF CIVIL CASE RECORDS IN THE UNITED STATES DISTRICT COURTS: GENERAL — Form 5 1-31

I

TRIAL

STYLE OF THE CASE (the named parties) ____

TYPE OF CASE 9, 10, 11 ____

Describe fully ____

ORIGIN OF CASE

No entry	12 Y
Original proceeding	12 0
Removed from State Court	12 1
Other specify ____	12 2

BASIS OF JURISDICTION

No entry	13 Y
Federal question	13 X
United States, federal official, board, commission or corporation a party	13 0
Diversity of citizenship	13 1
Combination of X and 1	13 2
Removal cases: federal question	13 3
Same diversity of citizenship	13 4
Same: diversity of citizenship: separable controversy	13 5
Same: diversity of citizenship: local prejudice	13 6
Combination of 3 and 4 to 6	13 7
Other specify ____	13 8

OBJECTIONS TO JURISDICTION

No objection made	14 Y
Made: no entry as to ruling	14 0
Made: objection overruled	14 1
Made: objection sustained	14 2
Other specify ____	14 3

RESIDENCE OF PARTIES: DIVERSITY OF CITIZENSHIP CASES ONLY

	Pl.	Def.
No entry on residence	15 Y	16 Y
Diversity of citizenship not involved	15 X	16 X
In State in which District is located	15 0	16 0
Outside State: private corporation (foreign or alien)	15 1	16 1
Same: doing business in State	15 2	16 2
Outside State: other foreign or alien party	15 3	16 3
Combination of 0 and 1 or 3	15 4	16 4
Combination of 0 and 2	15 5	16 5
Combination of 0 and 2 and 1 or 3	15 6	16 6
Other specify ____	15 7	16 7

TERMINATION 17, 18 ____

YY. No entry

LAW AND ADMIRALTY

00. Judgment on jury verdict
01. Judgment after directed verdict
02. Judgment notwithstanding verdict
03. Judgment by court: jury waived formally
04. Judgment by court: other waiver
05. Judgment by court: non jury case
06. Judgment by court: other
07. Judgment by default
08. Judgment by stipulation, consent, confession or compromise

EQUITY

10. Decree: after trial to the court
11. Decree after jury trial: verdict accepted
12. Same: verdict disregarded
13. Same: no entry as to court's handling of verdict
14. Decree after reference: report confirmed
15. Same: report rejected
16. Same: report rejected in part
17. Same: no entry as to report
18. Decree: other
19. Default decree (final decree pro confesso)
20. Decree by consent, stipulation or compromise

ALL CASES

30. Voluntary dismissal, discontinuance, withdrawal or nonsuit
31. Involuntary dismissal or nonsuit
32. Dismissed: no jurisdiction
33. Remanded to State Court
40. Other specify ____

TERMINATED FOR

No entry	19 Y
Neither party	19 0
Plaintiff	19 1
Plaintiff: against some defendants	19 2
Defendant	19 3
Intervener	19 4
Combination of 1 and/or 2 and 4	19 5
Combination of 3 and 4	19 6
Other specify ____	19 7

DATE OF TERMINATION Year 20, 21 ____
Code month as instructed Month 22 ____

DISMISSALS, DISCONTINUANCES, WITHDRAWALS, NONSUITS AND REMANDS: TIME

No entry as to time	23 Y
No dismissal, etc.	23 X
Before trial	23 0
During or after trial to court	23 1
During or after trial to jury	23 2
During or after hearings by referee or master	23 3
Other specify ____	23 4

AMOUNT AWARDED TO PLAINTIFF
Intervals of $1000 24, 25, 26 ____
Specify exact amount ____

AMOUNT AWARDED TO DEFENDANT
Intervals of $1000 27, 28, 29 ____
Specify exact amount ____

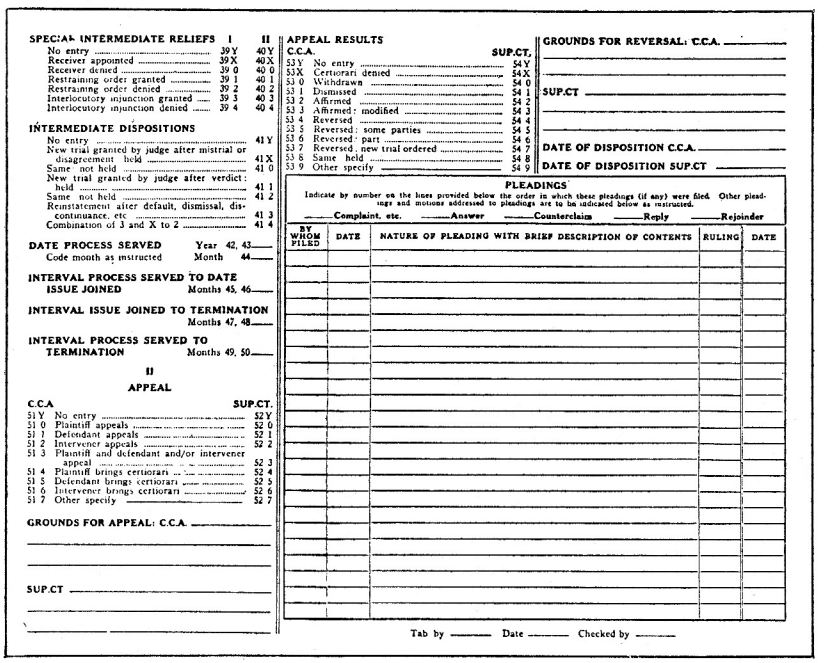
AMOUNT AWARDED TO INTERVENERS
Intervals of $1000 30, 31, 32 ____
Specify exact amount ____

OTHER RELIEF AWARDED TO PLAINTIFF 33, 34 ____
Specify ____

OTHER RELIEF AWARDED TO DEFENDANT 35, 36 ____
Specify ____

OTHER RELIEF AWARDED TO INTERVENERS 37, 38 ____
Specify ____

FIG. 187—Front of Federal Civil Form



SPECIAL INTERMEDIATE RELIEFS

	I	II
No entry	39 Y	40 Y
Receiver appointed	39 X	40 X
Receiver denied	39 0	40 0
Restraining order granted	39 1	40 1
Restraining order denied	39 2	40 2
Interlocutory injunction granted	39 3	40 3
Interlocutory injunction denied	39 4	40 4

INTERMEDIATE DISPOSITIONS

No entry	41 Y
New trial granted by judge after mistrial or disagreement held	41 X
Same not held	41 0
New trial granted by judge after verdict: held	41 1
Same not held	41 2
Reinstatement after default, dismissal, discontinuance, etc	41 3
Combination of 3 and X to 2	41 4

DATE PROCESS SERVED Year 42, 43 ____
Code month as instructed Month 44 ____

INTERVAL PROCESS SERVED TO DATE ISSUE JOINED Months 45, 46 ____

INTERVAL ISSUE JOINED TO TERMINATION Months 47, 48 ____

INTERVAL PROCESS SERVED TO TERMINATION Months 49, 50 ____

II

APPEAL

C.C.A	SUP.CT.
51 Y No entry	52 Y
51 0 Plaintiff appeals	52 0
51 1 Defendant appeals	52 1
51 2 Intervener appeals	52 2
51 3 Plaintiff and defendant and/or intervener appeal	52 3
51 4 Plaintiff brings certiorari	52 4
51 5 Defendant brings certiorari	52 5
51 6 Intervener brings certiorari	52 6
51 7 Other specify ____	52 7

GROUNDS FOR APPEAL: C.C.A. ____

SUP.CT ____

APPEAL RESULTS

C.C.A.	SUP.CT.
53 Y No entry	54 Y
53 X Certiorari denied	54 X
53 0 Withdrawn	54 0
53 1 Dismissed	54 1
53 2 Affirmed	54 2
53 3 Affirmed: modified	54 3
53 4 Reversed	54 4
53 5 Reversed: some parties	54 5
53 6 Reversed: part	54 6
53 7 Reversed: new trial ordered	54 7
53 8 Same held	54 8
53 9 Other specify ____	54 9

GROUNDS FOR REVERSAL: C.C.A. ____

SUP.CT ____

DATE OF DISPOSITION C.C.A. ____

DATE OF DISPOSITION SUP.CT ____

PLEADINGS

Indicate by number on the lines provided below the order in which these pleadings (if any) were filed. Other pleadings and motions addressed to pleadings are to be indicated below as instructed.

____ Complaint, etc. ____ Answer ____ Counterclaim ____ Reply ____ Rejoinder

BY WHOM FILED	DATE	NATURE OF PLEADING WITH BRIEF DESCRIPTION OF CONTENTS	RULING	DATE

Tab by ____ Date ____ Checked by ____

FIG. 188—Back of Federal Civil Form

cards and tally sheets, with which to locate the statistical nuggets.* It is, perhaps, not mere coincidence that it too found and recommended the punch card method to be an adequate one.

The effect of the activity of Yale, Johns Hopkins, the Wickersham Commission and others in judicial statistics has been to demonstrate the need and the value of adequate statistics and of the development of efficient and practical techniques for their collection. Since the commencement of that activity definite steps have been taken in various quarters, notably in the United States Census Bureau and in the Committee on Government Statistics, to create a standard of judicial statistics and to provide for their systematic collection both in state and federal courts.

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* The following are some of the materials published: Marshall, Unlocking the Treasuries of the Trial Courts (1933); Hotchkiss and Gehlke, Uniform Classifications for Judicial Criminal Statistics (1931); Marshall, Comparative Judicial Criminal Statistics: Ohio and Maryland (1932); also reports in connection with the Study of Judicial Administration in Maryland (By The Judicial Council of Maryland and The Institute of Law); and Study of Judicial Administration in Ohio (By The Judicial Council of Ohio, The Ohio State Bar Association and The Institute of Law); see also Marshall, Hotchkiss and Gehlke, Judicial Criminal Statistics—A Report to the Judicial Section of the American Bar Association and the National Conference of Judicial Councils.

PART VII

Applications in Legal Research

CHAPTER II

Judicial Criminal Statistics

By
RONALD H. BEATTIE
Research Assistant, Bureau of Public Administration, University of California

THE term "criminal statistics" has been applied indiscriminately to nearly every kind of quantitative or numerical statement made about crime or the administration of criminal justice. Consequently, there has grown up a certain public distrust of the validity of statistical data on crime, and this distrust has been further aggravated by the readiness with which both laymen and so-called "experts" bolster up their opinions and arguments concerning the defects in the administration of criminal justice with any figures that may fit their particular theories. It is quite apparent from the vagueness and instability of our quantitative information on crime in this country that we have no formal system of "criminal statistics" which offers complete and reliable information on the whole field of crime and criminal administration.

During the past decade there has developed a marked interest in our criminal law enforcement and a demand by the public to know what is actually going on in this field of activity. The early crime surveys,* with their revelations of how criminal administration actually operated, seemed to successfully break up the apathy which had been characteristic of the public attitude toward this subject previous to 1922. Students of criminal administration came to realize that the records kept by the various law enforcement agencies could, through proper organization, furnish the essential information concerning our whole law enforcement system.* *

With the growing demand for accurate official data to supplant sporadic and unstable statistical information on crime, has come a concerted effort to develop a statistical accounting system for the activities of the various law enforcement agencies. Out of the crime surveys came the idea that we should periodically and continually measure and analyse by a uniform method the work done by those engaged in criminal administration.

* Criminal Justice in Cleveland, edited by Roscoe Pound and Felix Frankfurter, 1922, The Cleveland Foundation, 729p. The Missouri Crime Survey, 1926 Macmillan, New York, 587p. The New York Crime Commission, Report of 1928, Legis. Doc. No. 23, 1928, 669p. The Illinois Crime Survey, 1929, Ill. Association for Criminal Justice, 1108p.

** See Roscoe Pound, What Use Can Be Made of Judicial Statistics, 12 Oregon Law Review, 89-95, Feb. 1933.

The attempt to develop a system of uniform criminal statistics has been experimented with in each of the functional areas charged with the administration of criminal justice, namely, the police, the court or prosecution, and the penal. The greatest progress toward a uniform system has been made in the first two areas named. Undoubtedly, further progress will be made in each of these three areas of criminal administration but the time is fast approaching when an integration of the three sets of statistics will be consummated and a reliable picture of the whole process of criminal administration may be obtained.

Statistics on prosecution or court action in criminal cases have been denominated "Judicial Criminal Statistics." Much work has been done in recent years toward the formulation of uniform and accepted classifications of information on the activity of criminal courts. Notable work has been done by the Johns Hopkins Law Institute, the Ohio Institute, the Census Bureau, and many other individual scholars and research agencies.* The Bureau of Public Administration of the University of California has been engaged since 1930 in a project which was designed to develop and test a statistical system of accounting for the work of the Superior Courts of the state in criminal cases.

Methods of Tabulating Judicial Statistics:

There are two distinct methods of compiling statistical information on the activities of the criminal courts of a state. The first, and most commonly recommended, requires the reporting of the activities of a court to a central agency of the state on uniform summary or tally sheets furnished to the various courts or counties for this purpose. The summary totals sent in from all courts or counties are then combined at the central office and totals for the entire state computed. It will be noted that while this method furnishes the total values for the state, no detailed analysis of the state totals, which goes any further than the summary figures furnished from each county, can be made. Thus if each county furnished figures on the total number of criminal cases handled, and distributions of this number according to the offense charged, the disposition made, and the punishment imposed, the total cases for the state and the total values for each of these three items would be available, but there would be no possibility of determining the relationships between any of these facts except on the basis of county totals. The tallying, or summarization, of the totals of each county which are entered on the summary sheet and sent to the central office, is usually done by hand. As long as the number of cases is not too large, and the variety of information desired is limited, this method may work very well. The hand method, however, does have limitations which may be avoided by the use of the alternative or second method.

The second method of compiling data on the criminal cases within a state requires no summarization or tallying on the part of local clerks or officials, but requires that a brief summary of the essential facts on each case or person be

* Judicial Criminal Statistics, Leon C. Marshall in collaboration with Willis L. Hotchkiss and Charles E. Gehlke. Institute of Law, Johns Hopkins University, 1932,, 56p.
A Statistical System of Criminal Statistics and Information, The Ohio Institute, Columbus, 50p.
A Standard Classification of Offenses for Criminal Statistics, adopted in 1932 for use in the Bureau of the Census, Department of Commerce, and the Bureau of Investigation, Department of Justice, Government Printing Office, Washington, 1933, 5p.

reported to the central office. This means that all classification and tabulation is done at the one place. This material is tabulated on a defendant or case unit basis and is usually done by machine methods rather than hand methods.

The Ohio Institute* discusses the second method just mentioned as follows: "It is obvious that from a statistical point of view, this method possesses certain marked advantages. Not to mention such an elementary matter as mathematical accuracy, uniform application of definitions and rules governing classification and compilation is much more easily secured through a small central office staff than through a large number of local officials scattered throughout the state. Also, much more intensive and complicated analyses can be made by the second method, which if sufficiently developed lends itself readily to the economies of modern statistical machinery."

The experimental project that has been carried on in California was planned and carried out as a test of the workability of this second method, and was devised primarily for the punch card method of tabulation. The techniques used, both in the reporting of the information and in the coding, punching, and tabulating of the data for California, are here presented.

It would seem advisable, before attempting to describe the complex procedure of compiling statistics by the second method, to demonstrate by a simplified illustration the actual operation and comparative efficiency of the two methods used.

Let us assume a county in which there are 200 felony prosecutions in a year. The essential data which are to be reported on each of these 200 defendants or cases** are the offense charged, the disposition of the case by the court, and the punishment imposed if a conviction resulted. The subdivisions to be used for each of these three items of information are as follows:

I. Offense Classification:

1. Homicide
2. Robbery
3. Assault
4. Burglary
5. Larceny and fraud
6. Forgery
7. Sex offenses
8. Narcotics
9. Other felonies

II. Disposition Classification:

1. Pleaded guilty on arraignment
2. Changed plea to guilty
3. Found guilty by jury
4. Acquitted by jury

* A Statistical System of Criminal Statistics and Information, The Ohio Institute, op. cit. p. 43.

** The terms "defendants" and "cases" are used interchangeably. It is accepted that the basic unit in judicial criminal statistics should be the defendant and all figures reported in terms of defendants handled.

5. Found guilty by court
6. Acquitted by court
7. Dismissed
8. Other disposition

III. Punishment Classification:

1. Capital
2. Prison
3. Probation
4. Jail
5. Fine
6. Juvenile institution
7. Suspended sentence
8. Other sentence

Under the first method of tabulation mentioned, that of tabulating the cases by hand, a summary tally sheet would be furnished to the county clerk to be filled out by him from his official records. The tally sheet would be in a form something like this. (See Fig. 189.)

The tabulation procedure would require a clerk to go through the docket or register of criminal actions of the county and tally each case disposed of during the year, once according to offense charged and disposition, and, for those convicted, once according to offense charged and punishment. It will be observed that there are 72 possible squares in each comparison, or 144 on the whole tally sheet. The hand tabulation of 200 cases in this manner is not a very difficult task, although the opportunities for error through tallying a case in an improper square are rather extensive.*

If this method is used in a county where 1000 cases a year are handled, the difficulties of correct tallying are greatly increased, and in such a county as Los Angeles, where there are some 5000 felony cases annually disposed of in the trial courts, the magnitude and complexity of hand tabulating becomes almost overwhelming.

The disadvantages of the hand tabulating method are not confined to the complexities of the method and the wide possibilities for error which are inherent in any attempt to tally by hand a large number of cases in a host of minute classifications. The most serious criticism of this method is the inflexibility of information which is finally tabuated. In the example just cited, the following information will be secured:

1. The total number of cases handled, shown according to offense charged and disposition.
2. The total number of convictions, shown according to offense charged and punishment.

* A very interesting report on the inaccuracies encountered in the process of hand tallying election ballots appears in the Nat'l. Mun. Rev., Aug. 1934, pp. 436-42, by Emmett L. Bennett of the Univ. of Cincinnati. "Hamilton County, Ohio Recounts Some Ballots." The tally sheets used in the election counting process have much in common with the tally sheets used under the hand method of tabulating judicial criminal statistics.

Disposition	Homicide	Robbery	Assault	Burglary	Larceny and Fraud	Forgery	Sex Offenses	Narcotics	Other Felonies	Total
Pleaded guilty on arraignment										
Changed plea to guilty										
Found guilty by jury										
Acquitted by jury										
Found guilty by court										
Acquitted by court										
Dismissed										
Other disposition										
Punishment										
Capital										
Prison										
Probation										
Jail										
Fine										
Juvenile institution										
Suspended sentence										
Other sentence										
TOTAL										

FIG. 189—Customary hand tally sheet

The total number of robbery cases will be known and the number convicted by a plea of guilty and by a jury trial will be known. Also, information of the total number of robbery defendants convicted and the number given a prison sentence is available. However, if any further analysis of the robbery cases is desired, such as the proportion of robbery convictions by plea of guilty which were sentenced to prison as compared to the proportion of robbery convictions by jury trial, so sentenced, no information will be available as the cases were not tallied in that way.

The weakness of this method is that only the specific values tabulated can be used and no further analysis of these values is possible. Of course more tally sheets could be provided which would allow the tabulation of the cases in many more two-way comparisons. But expansion along this line soon reaches the limits of physical possibility. A tally sheet for each offense group might be furnished which would compare the disposition of the cases of the particular offense with the punishment imposed. But this would mean nine more tally sheets to be filled out, and for even as small a total as 200 cases this becomes a complicated and time consuming task.

The development of card sorting and tabulating machinery however has revolutionized the field of accounting and statistics, in that the most complex relationships can be readily tabulated and determined by the punch card method. It is due to such machinery that the second method of compiling criminal statistics becomes possible.

How would these same 200 cases be handled if the information were furnished on a case basis and prepared for punch card tabulation?

In the first place, instead of the county clerk being required to tally and summarize the cases handled, he would be asked to fill out and send in to the central agency this simple report on each case disposed of by the court.

Case number .....Disposition.....
Offense charged .....Punishment.....

This task does not require any judgments as to classification or any tabulation on the part of the local official or clerk. He is merely asked to report the facts of each case concerning offense charged, disposition and punishment.

At the central agency, after these individual reports are received, a Hollerith punch card is prepared on which is coded the specific information as to the three items reported for the case.*

To code the information on the criminal cases, a column is assigned to each item of information. Information as to crime charged will be coded in column 1; information on disposition, in column 2; on punishment, in column 3. The numbers 0 to 9 in each column can be used to designate the particular subclassification to be coded for each general item of information. Thus for column 1 on offense charged, 1 will mean a homicide case, 2 a robbery case, 3 an assault case, etc., according to the classification set forth above. Thus 8 means a

* EDITOR'S NOTE: A description of the punch card above referred to and of the method of using it for a specific purpose will be found on pp. 3 to 6 incl. of this book.

narcotics charge and 9 other charges. In the same way, in column 2 on disposition, 1 will mean plead guilty on arraignment, 2 changed plea to guilty,etc. In column three on punishment, 1 means capital punishment, 2 prison sentence, etc.

It is a very simple matter to take each case report and code the three numbers that represent the information contained in the report. Thus a robbery case, in which the defendant was found guilty by a court, resulting in a sentence of probation would be coded:

Column number	1	2	3
Code values	2	5	3

A case which was coded 8-1-4, would be interpreted as a narcotics case in which the defendant pleaded guilty and was sentenced to jail.

After the code values are written and checked, a Hollerith card is punched out for each case. The material is then prepared and ready for machine sorting and tabulation.

A punch card sorting machine will separate the cards on any one column, according to the number punched out, at the rate of 400 per minute. Specifically, the 200 cards can be sorted on column one and thus be divided into the nine offense classifications used in just 30 seconds. Furthermore, not only does the operation sort out these cards at this rate of speed, but counts the total number of cards and the total of each subdivision sorted.

This method makes possible the analysis on a case basis of all the material coded on the punch card. The question, what proportion of the robbery cases pleading guilty were given prison sentences, as compared to the proportion found guilty by a jury given prison sentences is very quickly answered. First the robbery cases can be sorted out in approximately 30 seconds. These robbery cases can then be sorted on column 2 to determine the disposition groups in another few seconds, and then the robbery cases pleading guilty can be sorted on column three and the distribution of punishment immediately determined. This entire operation would require less than two minutes by the sorting process.

Once the information is coded on punch cards, values for any factor or combination of factors coded can be determined very rapidly. The information is completely flexible within the terms in which it is coded. Furthermore, a machine functioning properly makes no mistakes. If the original information has been carefully gathered, coded and punched, there is no worry or loss of time caused by errors in tabulation.

The advantages of using the second method for even 200 cases when only 3 factors or items of information are required seem obvious even though this small number could easily be tabulated by hand. The problem of studying what happens in the administration of criminal justice requires, however, the analysis of many factors connected with criminal cases, not only these three. Determination must be made, not only of how charge, disposition and punishment are related, but also of the sex of the defendant, the time involved in

each step of the process, the specific term of imprisonment, the conviction for a different offense than first charged, and the inter-relationships between all or any of these and many other factors or combinations of factors which enter into the administration of criminal justice. In other words, criminal cases must be analyzed in many ways to discover what influences and associations are related to efficient administration. It is only by the use of the punch card method that such complete analyses can be made. At the same time, the process of summarizing the total activity that occurs in the state can be more accurately and rapidly accomplished by this method. For these reasons, the California project was designed to develop the detail of a system of reporting criminal cases to a central bureau on the basis of the punch card method.

The California Project

Three California counties agreed to cooperate in this project by sending to the Bureau of Pubic Administration of the University of California the data on each felony case handled by the Superior Courts in their respective counties for the year July 1, 1931 to June 30, 1932. These counties were: Alameda, Los Angeles and Napa. At a later time information concerning the felony cases handled in San Francisco County for the same period of time was collected. The final report of this project deals with a comparison of Alameda, Los Angeles and San Francisco County cases. As there were only 31 felony cases from Napa County for the year covered, that county was not included in the final comparisons.

It was decided that two information cards would be required for each defendant prosecuted, the first to be filled out when the case was filed in the Superior Court and the second after the case was finally disposed of by the court. This procedure was adopted in order to have available the detailed information on pending cases as well as on completed cases.

The card illustrated on the opposite page, Fig. 190, was furnished for the first reporting of a felony case that was filed.

From this card the following items of information were obtained: (1) county; (2) docket number; (3) name of defendant; (4) type of prosecution initiated, whether information or indictment; (5) date of filing; (6) charge or charges filed, by counts (7) dates of alleged offenses; (8) previous convictions alleged.

The second information card filled out after final disposition of the case was made by the court was as follows (see Fig. 191).

The receipt of the second information card completed the reporting of all facts of the case to the central agency. The county, docket number and name of defendant were items which duplicated information received on the preliminary card, but were useful means of identifying the two cards belonging to the same defendant. New items of information furnished were:

1. Date of arraignment
2. Plea on arraignment
3. Amended plea

COUNTY	NAME
NO.	

REPORT OF FELONY CHARGE

ON AN INDICTMENT / INFORMATION WAS FILED AGAINST THE ABOVE DEFENDANT ALLEGING THAT ON HE COMMITTED THE OFFENSE OF:

1ST COUNT	
2ND	
3RD	
4TH	ALLEGED PREVIOUS CONVICTIONS
5TH	

FIG. 190

4. Date of first trial
5. Result of first trial
6. Result of second trial, if held
7. Whether court or jury trial
8. Charge of which convicted

COURT				
COUNTY	NO.	NAME		
DATE OF:				
ARRAIGNMENT		FIRST TRIAL		FINAL DISPOSITION
ORIGINAL PLEA				
INSANE	NOT GUILTY	GUILTY AS CHARGED	GUILTY OF:	
AMENDED PLEA				
INSANE	NOT GUILTY	GUILTY AS CHARGED	GUILTY OF:	
DISPOSITION:		TRIAL		
VERDICT BY JURY / COURT	INSANE	NOT GUILTY	GUILTY AS CHARGED	GUILTY OF:
SECOND TRIAL				
JURY / COURT	INSANE	NOT GUILTY	GUILTY AS CHARGED	GUILTY OF:
DISMISSED		OTHER DISPOSITION		
ALL COUNTS	COUNTS NOS.	SPECIFY:		
SENTENCE				
SAN QUENTIN / FOLSOM / OTHER INSTIT.	JAIL: MONTHS AND / OR FINE: $	PROBATION - ALL / SUSPENDED - ALL / SPECIAL CONDITIONS:	PART / PART	NUMBER OF PREVIOUS CONVICTIONS
APPEALS AND COMMENT:				

FIG. 191

9. Dismissal or other disposition
10. Sentence of those convicted.
11. Date of disposition

From these two cards giving the raw facts of each case in the superior courts, twenty-six items of information were selected to be coded and punched in the first 49 columns of an 80-column Hollerith punch card (see Fig. 192). These 26 items and the columns of the punch card assigned to each were:

Item Number	*Information*	*Columns Assigned*
1	County	1, 2
2	Court	3, 4
3	Date of filing	5, 6, 7
4	Docket number	8, 9, 10, 11, 12
5	Sex of defendant	13
6	Type of action	14
7	Offense charged	15, 16, 17
8	Counts	18
9	Pleas	19
10	Insane plea	20
11	Disposition	21
12	Dismissal	22
13	Trials	23, 24
14	Other dispositions	25
15	Convicted offense	26, 27, 28
16	Type of conviction	29
17	Nature of sentence	30
18	Probation term	31, 32, 33
19	Jail sentence	34, 35
20	And/or fine	36
21	Amount of fine	37, 38, 39, 40
22	Appeals	41
23	Time interval: filing to arraignment	42, 43
24	Time interval: arraignment to trial	44, 45
25	Time interval: arraignment to disposition	46, 47
26	Time interval: filing of disposition	48, 49

The process of coding the information for punching was carried out by writing the coded values on the back of the first information card received, in the order of the occurrence of the information on the punch card. (The codes used for each item are detailed later in this article). After this coding process was completed and checked the coded values for each case were then punched on a Hollerith card.

The coding of the values on the back of the first information card proved to be an awkward procedure, for it required frequent turning of the card as the first seven items of information used were on the face of this card. The place and method of coding the information to be punched is of importance

with respect to both efficiency and accuracy. As the result of this experience, it is believed that the most convenient place for coding the information would be at the bottom of the first data card, and that appropriate spaces should be printed there for this purpose.

Following is a sample of the eighty-column punch card used in this project:

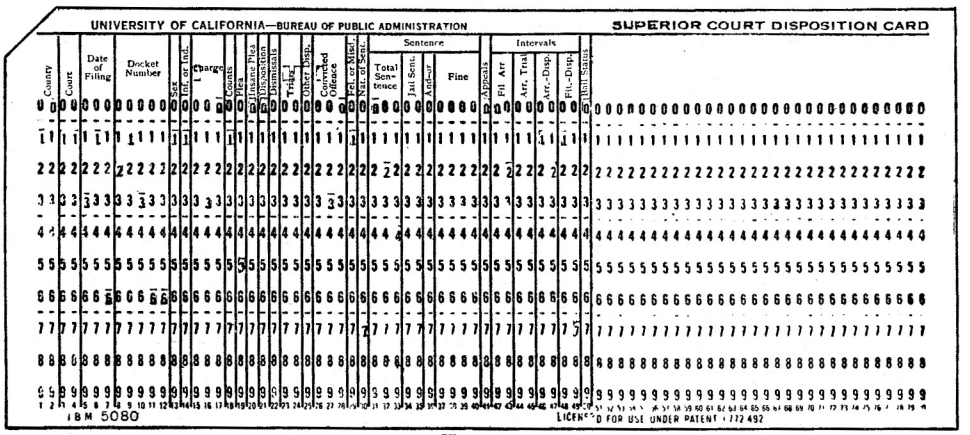

FIG. 192

From the coded values for the 49 columns written on the back of the first information card, the punch operator punches out the Hollerith card. A checking process on the punching is made possible by the use of the Hollerith verifier. The punch card is then completely ready for actual tabulation of the data and every piece of information desired can be run off on the sorting and tabulating machines.

Before any sorting or tabulating is done, work sheets are prepared for every comparison or tabulation that is known to be wanted. The advantage in having all these work sheets prepared before any work on the machines is attempted, is the increased efficiency with which the sorting and counting can be accomplished. Thus, if separation into offense groups is one of the most time consuming sortings to be made, and the offense groups are to be tabulated on the basis of ten other factors, it will save considerable time to sort the cards according to offense groups and, holding them in that order, to run off the information on the ten other factors. Otherwise, ten sortings into offense groups may be required at different times to prepare the cards for these particular comparisons. Careful planning of the order in which the information is run off on the machines and filled in on the work sheets will speed up the process considerably.

All of the tabulations done in this study were done on the counting-sorter; tabulators were not used. The development of the counting-sorter has made possible, not only the counting of the total number of cards passing through the sorter but also the count of the total cards sorted in each pocket. (The number of holes punched is counted, but in a scheme such as this of punching only one hole in a column, the total number of holes recorded in the count of a column and the total cards are identical). This means that in a one-column

item, the detailed frequency distribution can be obtained in one sort. Thus the 5000 Los Angeles cases were sorted and the distribution as to disposition (Column 21 on the punch card) was obtained within 15 minutes running of the machine.

Even in tabulating the time interval values, it was found that the work could be done as conveniently and effectively on the sorter as with a tabulator. The use of a printing tabulator would have furnished a minute frequency distribution and a summation of the time values; but the sorting operation would have been necessary to prepare the cards in order for the tabulator. The speed with which the cards could be sorted and counted and a frequency distribution written down, together with the convenience of carrying out all computations on a calculating machine, determined the use of this method of tabulating. Furthermore, to set up the tabulator for a specific tabulation requires some time and effort, while no effort is required for preparing the sorter, beyond the setting of the contact brush in line with the proper column, a procedure which takes but a second's time. The speed of the sorting operation is of tremendous advantage in confining the work to this machine.

The final work in compiling judicial criminal statistics is the preparation of pertinent tables of information from the material which has been tabulated and set down on the work sheets. An illustration of a work sheet used and examples of the final tables prepared in this study are presented later in this article (See pp. 345 to 346).

The method of gathering criminal judicial statistics which has been described here, lends itself very readily to routine procedure. Those local officials who cooperated found that it was a much simpler process for them to merely note down the raw information on each case appearing in the superior courts than to attempt to classify and tabulate a large number of cases themselves. This task fitted in with the routine of keeping the court records. Further, as has already been pointed out, to classify the cases for the whole state at one office makes for much greater uniformity and consequently greater reliability in the particular classifications used. All cases for the state can thus be interpreted from the same standpoint and therefore are really comparable.

The experience acquired through the work on this project has suggested several possibilities for improvement, and the possibility of obtaining information in addition to that which was gathered. In the adoption of such a system as this for official use by the state, considerably more of the available information should be required in the reports sent in on each case. In particular, the dates of each step in the process should be reported so that a more minute analysis of the elapsed time could be made. The date of the second plea of guilty, the time consumed in the actual trial, and the date the case is referred to the probation officer should be reported. The recommendation of the probation officer, the motions for a new trial and consequent rulings should be included. The reason for the dismissal of a case, the bail which was set and the facts as to whether the defendant was released on bail or recognizance, the department or judge disposing of the case, and the defense attorney should be reported. It is estimated that this additional information would consume an

additional eighteen columns of the punch card. This would still leave thirteen columns for other uses. While it may be more difficult to ascertain, as it is not a part of the court records, such personal information as the age, race, nativity, marital status and occupation of the defendant would be of considerable value. Further, reports as to the success or failure of probation, and of appeals, might be obtained and added to the punch card record of each defendant.

The true advantage of this system lies in getting all the useful information about a criminal case accurately coded on a punch card. Then the task of finding the relationships between any of the factors coded or any set of factors is a simple matter, and the totalling of any set of particular information for the entire state is a task easily and accurately performed.

Detailed code for the 26 items of the punch card

The detailed codes used in the California study for the 26 items of information are here presented for general information and to illustrate certain principles governing the formulation of codes with reference to punch card technique. It must be remembered that most of the tabulations desired will take the form of frequency distributions and that these can be most easily produced in the first instance by use of a counting-sorter. This means that all information used should be so coded as to simplify the amount of sorting required. This important principle of coding should constantly be kept in mind.

Item 1. County. Columns 1, 2

Code: 00—Alameda County
10—Los Angeles County
20—San Diego County
30—San Francisco County
40—Alpine County
41—Amador County

Etc. alphabetically

The advantage of coding the four most populous counties in values of tens, listing the remaining 54 in alphabetical order, is that approximately two-thirds of the cases are finally disposed of in the first sort (on column one). This means that only the remaining third have to be sorted on the second column in order to identify the county. Thus if 10,000 cases for the state were to be sorted by county, the first sort would accurately place some 6500 of them in the proper county and the remaining 3500 cards would be sorted again on column 2. The difference in time between sorting 20,000 cards, if the counties were coded strictly alphabetically and 13,500 cards as now coded is the difference between approximately 60 minutes of machine work and 40 minutes.

The remaining 54 counties do not necessarily need to be coded in alphabetical order. If there were a good reason to group them into geographical or population size groups, so that groups of 40's, 50's, 60's, 70's, 80's and 90's each represented a definite geographical or population classification, then the

first sorting (column one) would give the totals according to groups and the second sort would identify the actual counties.

Item 2. Court. Columns 3, 4

This item of information was not used in our experimental study as there was no record of the department of the superior court disposing of the case. However, it is desirable to obtain this information so that the work of specific departments or judges can be analyzed.

Item 3. Date of Filing. Columns 5, 6, 7

The first two columns of this item are used to record the year. Thus 1932 is coded "32" and 1934 coded "34". The last or 7th column is used to code the month in the accepted manner, utilizing all twelve punching positions.

Item 4. Docket number. Columns 8, 9, 10, 11, 12

The docket number is punched directly into these five columns. Thus docket number 72 is coded 00072; number 8463 is coded 08463, etc. This coding of the docket number gives a permanent means of reference from the punch card to the original report cards. Further, by having this number on the punch cards, they can be arranged in numerical order by the sorting machine and filed in that manner when the tabulating work is completed.

Item 5. Sex of Defendant. Column 13

The sex of the defendant is coded "1" for men and "2" for women. The determination of the sex was made entirely from the complete name of the defendant as reported. This is not a satisfactory method of classification on the basis of sex, as first names do not always accurately disclose the sex. In an official reporting system, information as to whether the defendant is a man or woman would be asked for in the original report of the case.

Item 6. Type of Action. Column 14

This study was concerned with felony cases only, and the only information possible as to type of action was coded "1", information filed, "2," indictment filed.

Item 7. Offense Charged. Columns 15, 16, 17

Three columns are devoted to the coding of the offense charged. Here again the code will be so organized that the first column (15) will give the large general distribution of offenses, the second column (16) will give sub-groupings of the main classifications, and the third column (17) will identify specific statutory violations.

Column 15

0—Homicide
1—Robbery
2—Assault
3—Burglary
4—Theft or larceny and fraud
5—Forgery
6—Sex offenses
7—Narcotics and liquor offenses
8—Weapons
9—Traffic
x—Miscellaneous offenses

By taking columns 15 and 16 together, subdivisions of the main offense groupings may be determined. Thus homicide is divided into murder and manslaughter. The following illustrates the divisions used in the theft and sex offenses.

Columns 15, 16

00—Murder
01—Manslaughter

40—Grand theft
42—Auto theft
43—Embezzlement
44—Receiving stolen property
45—Frauds

60—Rape
62—Prostitution and vice
63—Other sex offenses

The addition of column 17 allows the identification of the specific charges. The following shows how specific robbery and rape offenses may be identified by this means.

Columns 15, 16, 17

101—Robbery, first degree
102—Robbery, second degree
103—Assault with intend to rob
104—Attempted robbery

601—Rape (statutory)
602—Rape (forcible)
603—Assault with intent to rape
604—Attempted rape

From such a code, only one sorting or two for a few offences is necessary to classify the punch cards as to offense charged, and yet if at any time the cases of any particular statutory violation are wanted, they can quickly be selected.

The principle of determining what offense will be coded, where several offenses are charged against a defendant, is based upon the relative punishment provided by law for each offense. The most serious offense, as determined by the statutory punishment, is coded as the offense charged.*

Item 8. Counts. Column 18

The actual number of counts are coded with the exception that if there are more than nine counts the value X will be coded.

* See Uniform Rules of Counting set out in Judicial Criminal Statistics, Johns Hopkins Institute of Law, op. cit. p. 10-11.

Item 9. Pleas. Column 19

In this column are coded the combination of pleas that may have been entered in the case.

0 No plea
1 Plea of not guilty on arraignment
2 Plea of guilty to the offense charged on arraignment
3 Plea of guilty to a lesser felony on arraignment
4 Plea of guilty to a misdemeanor on arraignment
5 Plea of not guilty on arraignment, changed to guilty of offense charged
6 Plea of not guilty on arraignment, changed to guilty of lesser felony
7 Plea of not guilty on arraignment, changed to guilty of misdemeanor
8 Plea of guilty on arraignment changed to not guilty

From this code three main classes of pleas can quickly be distinguished. The defendants who plead only not guilty, those who plead guilty on arraignment, and those who changed their original plea of not guilty to guilty subsequent to arraignment.

Item 10. Insane plea. Column 20

This information is desirable in any attempt to find the extent of the use of a plea of insanity and what happens in the cases in which it is used.

0 No insanity plea
1 Plea of insanity only
2 Plea of insanity and not guilty
3 Plea of insanity and guilty

Item 11. Disposition. Column 21

The disposition is one of the controlling factors in any study of criminal justice. The chief point of interest is invariably the final outcome of court action in criminal cases. It is a principle of coding that one should always be able to determine his major or controlling classifications at any time in a single sorting. The three major items in criminal court statistics are the charge, the disposition, and the punishment. Thus general dispositions are confined to one column. Particular details can be determined from further analysis of other items on the card.

0 Pleaded guilty on arraignment
1 Changed plea to guilty
2 Found guilty by jury
3 Found guilty by court
4 Acquitted by jury
5 Acquitted by court
6 Found insane by jury
7 Found insane by court
8 Dismissed
9 Off calendar
x Other disposition

Item 12. Dismissal. Column 22

When the disposition is a dismissal, much more specific knowledge is required as to what point in the trial process of a criminal case the dismissal occurred.

0 All counts dismissed before trial, no plea
1 All counts dismissed before trial, pleaded not guilty

4 All counts dismissed after trial, jury disagreement
5 All counts dismissed after trial, jury mistrial
6 All counts dismissed after trial, jury conviction
7 All counts dismissed after trial, court conviction
8 Convicted or acquitted on some counts, others dismissed
9 Pleaded guilty to some counts, others dismissed

No information was obtained as to the cause of dismissal. Such information is important and in an official system should be required. Another column could then be devoted to the reasons for dismissal.

Item 13. Trials. Column 23, 24

Column 23 is used to code information concerning the first trial, and column 24, information on the second and subsequent trials.

Column 23

x No trial
0 Convicted or acquitted by jury
1 Convicted by jury but new trial granted
2 Convicted by jury, amended plea allowed
3 Jury disagreement
4 Jury mistrial
5 Convicted or acquitted by court
6 Convicted by court, new trial granted
7 Convicted by court, amended plea allowed

Column 24

x No second trial
0 Convicted or acquitted by jury: second trial
1 Jury disagreement: second trial
2 Jury mistrial: second trial
3 Convicted or acquitted by court: second trial
7 Second trial jury disagreement: 3rd conviction or acquittal
8 Second trial jury disagreement: 3rd disagreement

No facts concerning motions for new trial were obtained in the information secured for this experiment, but such information should be furnished and coded under a regularly installed system of reporting criminal cases.

Item 14. Other dispositions. Column 25

This column is devoted to giving the detail of those miscellaneous and infrequent types of disposition which have been coded "other disposition." Only three types of other dispositions were found in the cases studied.

1. Transferred to juvenile court
2. Released on habeas corpus
3. Jumped bail—bail forfeited

Item 15. Convicted offense. Columns 26, 27, 28

The code values for convicted offense are identical with those for offense charged.

Item 16. Type of Conviction. Column 29

This column is introduced as a one-sort control on the convictions for lesser offenses.

0 No conviction
1 Convicted of felony offense charged
2 Convicted of lesser felony offense
3 Convicted of misdemeanor

Item 17. Nature of sentence. Column 30

The attempt is made here to code all convictions according to the main punishment groups that are desired for the study.

x No sentence
0 Death
1 San Quentin
2 Folsom
3 Probation and jail
4 Probation only
5 Jail or jail and fine
6 Fine only
7 Juvenile institution
8 Sentence suspended
9 Other sentence (This value was not needed or used in the cases of the experimental study)

Item 18. Probation term or total sentence. Columns 31, 32, 33

The values coded here are the total terms of probation stated in actual months.

012 one year
060 five years
120 ten years
etc.

Item 19. Jail sentence. Columns 34, 35

The jail sentence is coded in terms of months.

01 one month
04 four months
etc.

Values of less than a month can be coded with an X in the first column and the second column in values of tenths of months, if desired.

Itlem 20. And/or fine. Column 36

The determination whether a fine has been imposed and whether it is imposed in relation to some other sentence can be made from Column 36.

0 No fine
1 Fine only
2 Some other sentence *and* fine
3 Some other sentence *or* fine

Item 21. Amount of fine. Columns 37, 38, 39, 40

Actual amount of fine imposed is punched in these columns (Dollars only).

Item 22. Appeals. Column 41

This column was provided to record the information on those cases in which an appeal was taken, but as complete information was not always available at the time of the reporting of the final disposition, this column was not used. It

is possible that complete information on criminal appeals could be reported or obtained from appellate court sources and this additional information be included on the Hollerith punch card under an official system.

Item 23 to 26 incl. Time Interval Coding. Columns 42 to 49 incl.

Each time interval has been assigned two columns on the punch card. Where the interval is relatively small as between "filing" and "arraignment" the actual elapsed days are punched. For the other intervals the punched figures represent tenths of months and thirds of months respectively.

Work Sheets

Following is a sample of a work sheet used to record the information as run off on the counting-sorter.

Work Sheet No. 7
County: Alameda
Year: 1931-32

CALIFORNIA JUDICIAL CRIMINAL STATISTICS
Tabulation
Offense Charged: Columns 15, 16, 17 and Disposition: Column 21

	Offense Charged	x Other Disposition	0 Plead Guilty	1 Plead Not-Guilty to Guilty	2 Found Guilty by Jury	3 Found Guilty by Court	4 Acquitted by Jury	5 Acquitted by Court	6 Found Insane by Jury	7 Found Insane by Court	8 Dismissed	9 Off Calendar	Total
Column 15													
0	Homicide	..	..	11	5	2	2	..	..	..	1	..	21
1	Robbery	..	31	21	14	6	3	2	..	..	9	..	86
2	Assault	..	..	9	6	1	..	1	2	..	2	..	21
3	Burglary	..	53	16	11	1	4	3	2	..	7	..	97
4	Theft	..	43	23	11	9	3	2	..	..	4	..	95
5	Forgery	..	79	20	2	2	..	..	..	..	7	1	111
6	Sex	..	6	7	10	8	2	2	..	..	2	..	37
7	Narcotics	..	22	7	..	1	..	1	..	..	3	..	34
7	Liquor	..	..	3	..	1	1	1	..	..	..	..	6
8	Weapons	..	1	..	2	..	..	..	..	..	..	..	3
9	Traffic	..	11	13	1	3	..	1	..	..	2	..	31
x	Miscellaneous Felonies	..	5	..	3	2	5	..	..	..	1	..	16
	Total	0	251	130	65	36	20	13	4	0	38	1	558

FIG. 193
Work Sheet

The filling out of this particular work sheet required, first, that the Alameda County cases be sorted, if they had not been already filed separately. This group of 558 cases were then sorted on Column 15 to separate offense groups. The sorter does this in about 90 seconds. From the work sheet it will be observed that the No. 7 group of Column 15 will have to be re-sorted on Column 16 to divide the narcotics and liquor cases. This re-sorting of 40 cards takes

about seven seconds. The twelve groups of offense classifications are thereupon laid aside separately. First, the homicide group of 21 cases are sorted on column 21, for disposition, the results noted down in the proper spaces of the work sheet, the machine cleared, and each offense group sorted on the disposition column. Within ten minutes the work sheet is completely filled out and the total number of 558 cases can be run on the disposition column if a check of the totals is wanted.

Preparation of Summary Results

The work sheets furnish the accurate and complete information in tabulated form. If certain summaries are to be published or certain studies are made, the specific tables giving these summaries are made up from this work sheet.

The Bureau of Public Administration is publishing the results of its one year's sampling of the criminal cases for the three most populous counties of the state. From the work sheets the tables to be published are made up, and averages and percentages computed by means of calculating machines.

Following is a table from the manuscript of the report being prepared which show how the material given in the worksheet (Fig. 193) is used for final summary or publication. Fig. 194 shows the total number of cases disposed of in each of the three counties studied, distributed according to the general disposition made.

DISPOSITION OF FELONY CASES IN THE SUPERIOR COURTS OF ALAMADA, LOS ANGELES, AND SAN FRANCISCO COUNTIES, 1931-32

	Alameda County		*Los Angeles County*		*San Francisco County*	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total Cases Disposed of....	*558*	*100.0*	*4940*	*100.0*	*1209*	*100.0*
Total Eliminations	*76*	*13.6*	*1268*	*25.7*	*405*	*33.5*
Acquitted by jury.....	24	4.3	226	4.6	122	10.1
Acquitted by court.....	13	2.3	266	5.4	14	1.2
Dismissed	38	6.8	650	13.2	251	20.7
Off Calendar	1	.2	126	2.5	18	1.5
Total Convictions	*482*	*86.4*	*3672*	*74.3*	*804*	*66.5*
Plead Guilty on arrignment	251	45.0	1388	28.1	312	25.8
Changed plea to guilty..	130	23.3	1425	28.8	328	27.1
Found guilty by jury....	65	11.6	517	10.5	152	12.6
Found guilty by court....	36	6.5	342	6.9	12	1.0

FIG. 194

Conclusion

The punch card method of tabulation has opened up for the first time possibilities of obtaining accurate and detailed knowledge of the diverse activities of the many agencies of criminal administration. Without such a method it would be impossible to learn what actually happens to large masses of criminal cases which pass through the devious paths of criminal prosecution, from arrest to punishment.

Not until such methods of analysis were available was it possible to conduct the intensive studies of criminal administration carried on by the various crime surveys. The Cleveland survey* the Illinois survey** and the intensive analyses carried on in the Oregon study of the administration of criminal justice,*** have all depended on punch card equipment for the tabulations made. In fact, it is doubtful if the extensive material presented by these studies could have been made available without the use of punch card machinery.

There is today a tendency to do a great deal of reforming of our criminal law and procedure. Such efforts at reformation are based on the assumption that the weaknesses in our criminal administration are largely due to archaic procedures and obsolete legal structures, and that the modernization of these elements of justice will bring about the desired improvement. There is undoubtedly something to be said for improving our procedure of criminal administration, yet procedural reforms have been introduced at almost every state legislative session for many years, but the criticism of the criminal courts still goes on.

There are two phases in the attempts to improve criminal administration by means of procedural changes, which are not properly taken into account. In the first place, if there is no reliable measurement of the activities and results of the criminal procedure, how can those innovations which improve administration be identified and retained, while those changes which hinder are singled out and abandoned. Secondly, the part played by "procedure" in our criminal administration is not the dominant part. Rules of procedure, and even substantive criminal law itself are no more than instruments in the hands of public officials by which they try to accomplish a certain end or objective, namely the insurance of the reasonable safety and welfare of the members of the community. Laws are not self-enforcing and rules are not self-guiding. In other words, the administrative activity of those human beings who as public officials have the responsibility of administering criminal law and its enforcement is of greater importance in our system of justice than anything else. Police, sheriffs, prosecutors, judges, wardens, all within their functional areas, exercise more discretion than the ordinary citizen realizes. Such a state of affairs is necessary for any degree of efficient administration. However, it is neither desirable nor proper to place blind faith in those who administer a position of public trust; there must be some means of accounting publicly for the work of these officials and the manner in which they have accomplished it. Such a means of accounting is the prime object of systems of criminal statistics, and in the field of judicial criminal statistics, it is possible, as has already been outlined, to continually provide for detailed knowledge of what occurs in the work carried on by the public prosecutors and criminal judges. No truly responsible official can fail to welcome a detailed analysis of his administration, and no irresponsible official should be in a position to avoid a strict accounting for his activities.

Mass criminal statistics, such as developed by the use of the punch card method, do not furnish all information desired on crime and criminals. In fact,

* Criminal Justice in Cleveland, edited by Roscoe Pound and Felix Frankfurter, 1922, The Cleveland Foundation, 729p.

** The Illinois Crime Survey, 1929, Ill. Association for Criminal Justice, 1108p.

*** The Administration of Criminal Justice in Oregon. Report No. I on 1771 Felony Cases in Multnomah County. Wayne L. Morse and Ronald H. Beattie, Univ. of Oregon Press. 1932. 227pp.

they tell nothing about the individual case or the defendant; but such material does furnish the summary of what has happened as a whole, and by analysis of the various steps and factors in the whole process, does reveal what trends and tendencies are to be found in the administrative activity.

The fact that punch cards can be retained and filed as permanent records is of particular value in making possible material for time analyses. The accumulation of detailed knowledge on all criminal cases in a state or jurisdiction over a ten year period will make possible a most revealing study of fluctuations and changes of both the effectiveness of certain procedural rules and, more particularly, of administrative practices.

The need for accurate and comprehensive knowledge of the various activities of government grows more acute with every extension of government functions. The punch card method of preparing information on a unit basis so that the most detailed analyses can be made of this information is an essential feature of the modern trend of government expansion. That such expansion must take place is beyond a doubt, but it is fortunate that methods of accounting have been and are being developed whereby the people can be reliably informed of the activities carried on by administrative officials and be in a position to adequately judge the performance of these responsible public servants.

PART VIII

Applications in Agricultural Research

PART VIII

Applications in Agricultural Research

CHAPTER I

Animal and Plant Breeding

By
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Animal Breeding *

IN animal breeding it is important, in mapping or planning systems of breeding for the present, to know how the established breeds of livestock were developed or produced. The systems used can be deduced from the records which appear in the herd books of the various breeds. In the studies of these herd book records three questions commonly asked are: first, what amount of inbreeding was practiced; second, to what degree is the breed as a whole related to the foundation animals or more recent animals which have become important in the breed; and third, has the breed developed as a rather homogeneous unit or has it perhaps been split into many families more or less different from each other, largely non-interbreeding and sometimes competing with each other.

It is obvious that in a large breed it would be impractical if not impossible to study the inbreeding and relationships of every animal recorded. To obviate this difficulty a method of sampling has been devised.** In this plan a certain number of males and females are selected at random out of the herd book in which are registered those animals born at the dates for which the breeding system is being studied. For instance, in a herd book study of the Holstein breed conducted at Iowa State College under the direction of Dr. Jay L. Lush, a sample of the breed was studied at each ten year interval beginning with 1890, 200 males and 200 females being selected from the herd books for each such 10-year interval.

The number and sex of each individual selected and the numbers of the sire and dam are recorded. A line of ancestry from the sire and a line of ancestry from the dam are then traced back at random to the foundation animals. The sex of the animal to be selected in each generation is determined by flipping a coin. In Figure 195, a typical two line pedigree is given. The number and sex of the subject or individual are given in the upper left-hand corner. The other headings are self explanatory.

The material on these pedigree sheets is next punched on cards. Specially printed cards are not needed so the regular IBM 5080 form is used. One

* This part of the chapter written jointly by A. E. Brandt and Marjorie McCrabb, Animal Breeding Subsection, Animal Husbandry Department, Iowa State College.

** For description of the method and of the genetic principles involved, see Wright, S. 1925, J. Agr. Res. 31, No. 4 :377-383.

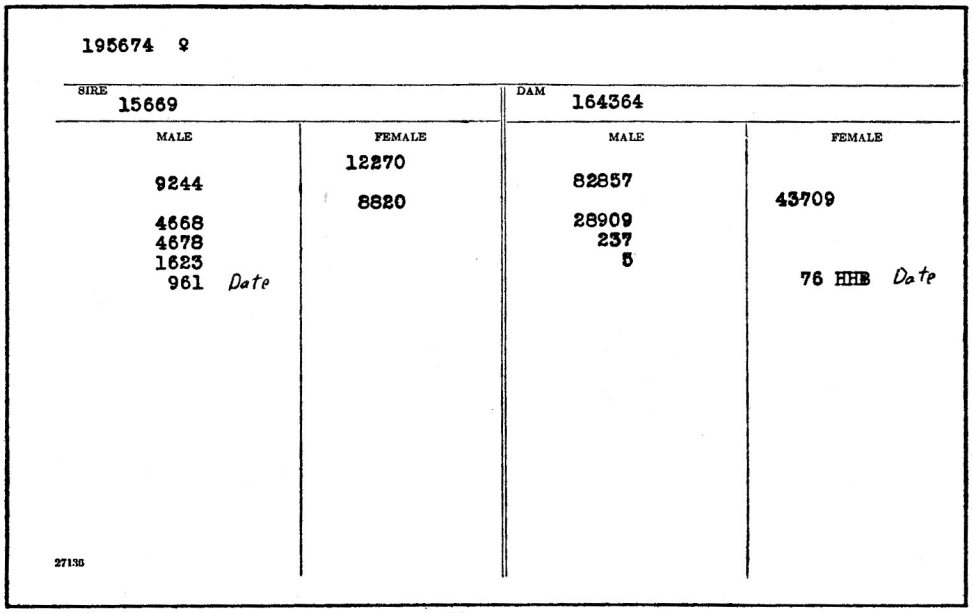
card is punched for each ancestor on a pedigree. The automatic duplicating punch is especially useful in this operation for a master card bearing the number and sex of the subject and the line or family of the pedigree can be used for all the ancestors in one line, leaving the number and sex of the ancestor and the date or year of birth of the last ancestor in the line to be punched. Since only a portion of a card is used in each study, it may be used in more than one such study.

After the cards are all punched they are sorted first on subject then on ancestor and then listed. A sample section of the tabulator tape is shown in Figure 196. In the first column appear the numbers of the various ancestors; in the second, the sex of the ancestors; in the third, the family or line, that is, whether an ancestor of sire or dam; in the fourth, the sex of the subject; in the fifth the number of the subject; in the sixth, the year of birth which appears only when the ancestor in question was the most remote ancestor in one line of the subject's pedigree; and in the seventh, the number of times a given ancestor appears in the lines of animals chosen at random from the breed.

In calculating the relationship of an animal to the breed, the ratio of the number of times an animal appears to the total number of times it might have appeared must be determined. This quantity is calculated only for foundation animals or animals which through breeding practice, either consciously or otherwise, have been brought into pedigrees often. One special advantage of the machines is in determining quickly which ancestors have thus been important. If an animal appears 16 or more times in two or more samples or if it appears 20 or more times in a single sample, a sample being the group of animals selected from a single book, Dr. Lush and his workers consider it to be important, although this depends on the size of the sample and on peculiarities of the breed being studied.

In calculating the average percentage of inbreeding for a breed, the animals which appear on both sides of a pedigree are found and their inbreeding coefficient determined from their pedigrees. These animals are easily found from the tabulator tape. Thus, in Figure 196, ancestor number 1271 appears twice in the pedigree of subject number 292427, once in each line as shown by the 1 and 0 in the third column.

The chief advantages of tabulating machines in a study of this kind lie in the speed and accuracy with which the data are handled and the concise form in which they are presented with all the information concerning each ancestor in one place fully listed and counted. Such an arrangement makes it possible to select the ties and to find the really important ancestors without the great fatigue and large chance of error which accompany, what might be termed, long-hand searching through pedigrees. In the latter method only a few animals can be classed as foundation or important animals and they must be chosen rather arbitrarily while the present method not only furnishes the information on all ancestors which would enable one to determine their degree of relationship but also furnishes the information by which they may be picked out.



195674 ♀

SIRE 15669

MALE	FEMALE
9244	12270
4668	8820
4678	
1623	
961 Date	

DAM 164364

MALE	FEMALE
82857	43709
28909	
237	
5	
	76 HHB Date

27136

FIG. 195
A typical two line pedigree

Ancestor	Sex	Family	Sex	Subject	Year	No.
990	1	0	1	296377		
990	1	0	0	543822		
990	1	0	0	555058		3
1019	0	1	1	293784	84	1
1110	0	1	1	291970		1
1271	1	1	1	288214		
1271	1	0	1	288306		
1271	1	1	1	288366		
1271	1	1	1	289047		
1271	1	1	1	289323		
1271	1	1	1	289445		
1271	1	0	1	290599		
1271	1	1	1	290794		
1271	1	1	1	292427		
1271	1	0	1	292427		
1271	1	1	1	292905		
1271	1	0	1	293027		
1271	1	1	1	294028		
1271	1	0	1	296011		
1271	1	1	1	296255		
1271	1	0	0	539428		
1271	1	0	0	541302		
1271	1	1	0	542370		
1271	1	1	0	543822		
1271	1	1	0	548700		
1271	1	0	0	551927		
1271	1	0	0	552748		
1271	1	1	0	553843		
1271	1	1	0	554384		
1271	1	0	0	556290		
1271	1	0	0	557767		
1271	1	1	0	561638		
1271	1	0	0	562688		28

FIG. 196
Section of tabulator tape

Corn Breeding

IN modern corn breeding, the development of superior crossbreds or hybrids from inbred strains of corn holds a very important place. In this work a very large number of inbreds are produced and all combinations of each with every other must be tested in order to find the best hybrids. In this way many inbreds are discarded and only a relatively small number of the combinations of those retained are recommended for production. It is not sufficient to compare the inbreds because they themselves are of no commercial value on account of very low yield per acre and because no one has as yet been able to predict from the qualities of an inbred what its effect in a cross will be. This is due chiefly, perhaps, to the phenomenon know as hybrid vigor. It has been recognized for a long time that crosses between different strains, varieties or races of plants and animals frequently produce progeny that are superior to or more vigorous than the parents. This manifestation following out-crossing or hybridizing has been called hybrid vigor or heterosis.

It becomes necessary, then, in the production of superior hybrids to test them under field conditions for yield, time of maturity, stiffness of stalks, placing of ears on stalk, resistance to smut and various other characteristics. Quite obviously, these hybrids will vary in these respects but it is necessary to attempt to answer the question as to whether these differences can be assumed to be chance ones and therefore not predictable or whether they are due to the efficacy of a cross and predictable. To answer this question it is necessary to replicate each cross several times so a comparison of replicates may be used as a standard with which to compare the observed differences.

If the various replications of the hybrids to be tested should all be planted with the crosses in the same position in each block, it would be difficult to decide whether or not a difference were large enough to be significant, for differences in the crosses might be confused with differences in fertility or other favorable or unfavorable characteristics of the experimental plot. Thus, it would be possible for an inferior cross, if systematically arranged in each replication, to occupy a position more favorable than that occupied by a much better cross, if tested under equally favorable conditions, and thus be adjudged the better cross of the two. This difficulty is obviated by arranging the planting wholly at random.

In this phase of corn breeding, then, the problem of planting the seed, taking observations on the resulting crop, and the subsequent analysis of the differences observed becomes very large indeed if more than a few crosses are to be tested. Dr. M. T. Jenkins who is in charge of corn breeding work in the United States Department of Agriculture has devised a system with punched cards which simplifies this problem considerably.

The first step in his system is to stamp a code number representing the kind of corn and a pedigree number on a number of small manila envelopes, Fig. 197, and to put the required amount of seed in each. This is done for each kind of corn to be tested. The number of envelopes for each kind of corn must be the same as the number of replications. For block one, then, one envelope of

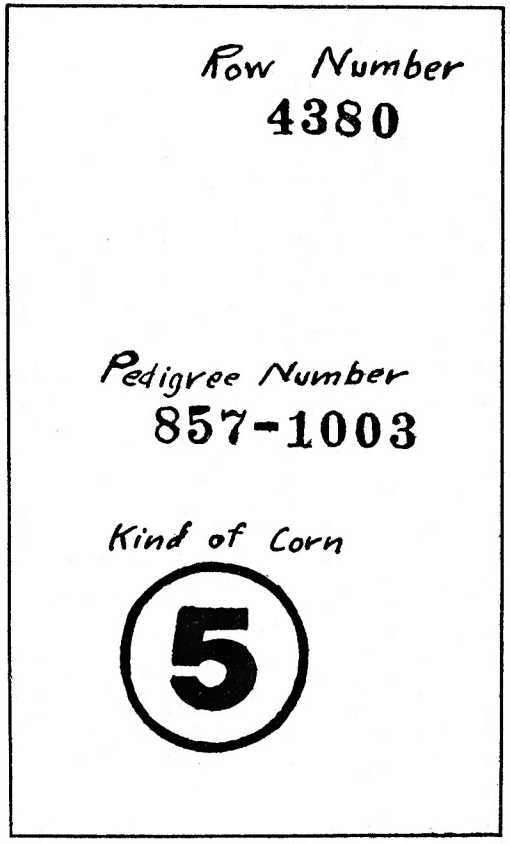


FIG. 197

Front view of Manila Seed Envelope
(actual size)

Row No.	Kind of Corn	Pedigree	Broken Stalks	Down Stalks	Plant Ht.	Ht. of Ear	Missing Hills	Total Stand June	No. of Plants Erect	Leaning	Down	Broken	Smut	No. Ears	Moldy Ears	Field Wt.	Dry Wt.	Cob Wt.	Remarks
1510	15	422003	0	0	8.0	42		41	41	05	00	02	1			15.8			
1511	15	8171003	0	2	8.0	32		42	42	00	00	00	1			18.0			
1512	15	65222003	0	3	7.5	36		42	41	03	01	05	1			14.7			
1513	15	6391003	0	3	8.0	30		42	44	02	02	01	1			14.3			
1514	15	8501003	0	3	8.0	36		42	42	02	00	01	1			15.0			
1515	15	1281003	0	2	8.5	36		42	43	05	00	02	1			20.2			
1516	15	8161003	0	3	8.5	36		42	42	00	00	02	1			13.6			
1517	15	8241003	1	3	8.0	36		42	42	00	00	02	1			16.3			
1518	15	6451003	0	3	8.0	36		42	44	04	01	05	1			17.7			
1519	15	8681003	0	3	8.0	36		42	43	05	01	02	1			15.3			
1520	15	1111003	0	3	8.0	36		42	42	10	04	04	1			16.0			
1521	15	1112003	0	2	8.0	36		42	42	18	00	02	1			19.4			
1522	15	561003	0	3	8.0	40		41	43	11	01	02	1			16.2			
1523	15	1021003	0	2	8.0	30		43	42	04	01	05	1			18.1			
1524	15	6521003	0	3	8.0	30		42	42	07	01	01	1			14.2			
1525	15	461003	0	3	9.5	34		42	42	01	00	00	1			18.4			
1526	15	271003	0	2	8.0	30		42	42	03	00	02	1			18.2			
1527	15	7251003	0	2	8.0	38		42	42	05	00	01	1			18.0			
1528	15	7261003	0	3	7.5	35		41	42	01	00	00	1			13.8			
1529	15	6411003	0	3	9.5	30		39	40	01	02	02	1			13.7			
1530	15	6532003	0	2	8.0	32		42	41	05	00	01	1			16.5			
1531	15	8281003	0	3	8.0	36		41	41	03	02	04	1			15.1			
1532	15	1531003	0	3	7.5	34		41	42	02	01	06	1			15.2			
1533	15	6421003	0	3	7.5	36		42	42	08	01	02	1			17.0			
1534	15	8401003	0	3	8.0	30		41	41	02	00	00	1			15.5			
1535	15	692003	0	3	8.0	30		42	41	00	00	04	1			15.2			
1536	15	8221003	0	3	7.5	30		41	41	01	00	03	1			14.9			

FIG. 198

A sample page of the Field Note Book

seed of each kind of corn is placed in a churn. The churn is whirled, the lid opened and an envelope removed and stamped with the row number. A card is then punched for this envelope and the envelope is placed in a box which later is carried to the field at planting time thus insuring that the planting is done according to plans of the investigator. When all the envelopes for a block have been removed from the churn, a card punched for each and the envelopes and cards filed properly, envelopes for another block are put in the churn and the process repeated.

After the cards are all punched they are taken to the tabulator and the pages for the field note book made up, Fig. 198. These numbers were printed directly by the printing tabulator. The penciled numbers are the data collected during the season. After all the data for the season have been collected, the punching of the cards is finished and the final analysis of the results of the experiment made.

The chief points of superiority of this system are speed and accuracy. When the pages for the field note book are prepared any errors such as leaving out a kind of corn in a block or putting more than one envelope for any one kind of corn in a block are found and the necessary corrections made before the planting is done. Material for the various tables and statistical tests are quickly secured from the cards by means of the sorting and tabulating machines.

PART VIII

Applications in Agricultural Research

CHAPTER II

Agricultural Economics in General

By
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HOLLERITH punched-card equipment has been used for several years by the Department of Agricultural Economics at Cornell University. The first installation, made in March 1926, consisted of one 45-column hand key punch, one key verifier, one gang punch, one sorting machine, and one five-counter tabulating machine. The present equipment consists of two sorters, two five-counter tabulators, two ordinary electric punches, two duplicating punches, and two verifiers, all of which are designed for 80-column cards. This equipment is used entirely for research work.

The general applications of punched-card tabulating equipment in Agricultural Economics research are similar to those in other fields. Its adaptation to handling large amounts of data rapidly and accurately, and the ease and flexibility by which relationships may be studied are probably the greatest advantages of the equipment in this field.

Farm Management Research

In Farm Management research, tabulating equipment may be advantageously employed in many ways, but is especially useful in grouping or classifying data to study the relationships between certain factors. For example, it is frequently desired to determine, from a group of farm records, the important factors affecting farm incomes. If the number of records is sufficiently large, the work is greatly facilitated by the use of punched-card equipment. Through the process of sorting, sub-sorting, and tabulating, it is possible to group and isolate different elements and to study their effects on income.

A typical example of the application of the punched-card method to research of this type is illustrated in a general farm-management study made in Livingston County, N. Y.* Data concerning farms in the same area for three different periods (1908, 1918, and 1928) were brought together on six different 80-column cards. One of the cards is shown in Figure 199. By the use of

* Warren, S. W., An Economic Study of Agriculture in Northern Livingston County, New York, Cornell University Agricultural Experiment Station, Bulletin 539. May 1932.

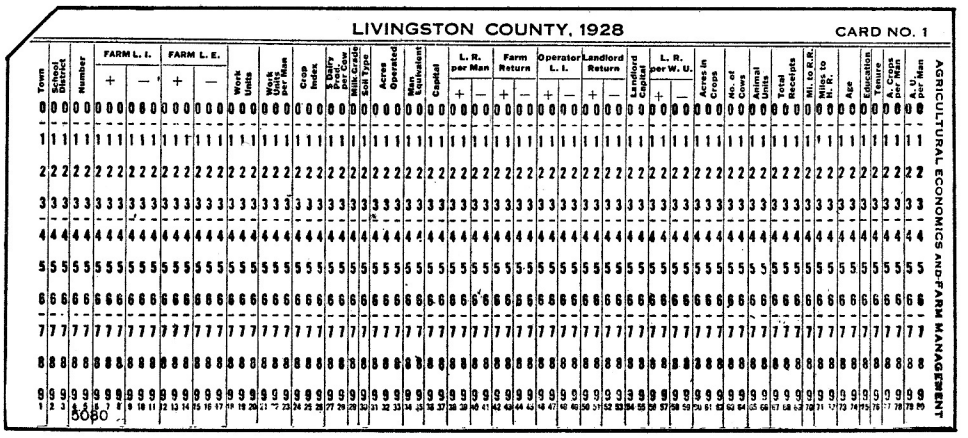
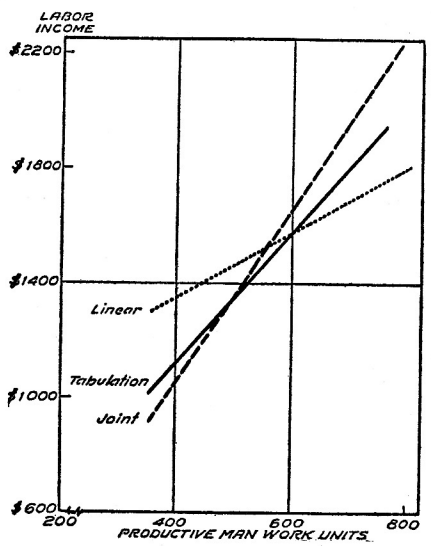


FIG. 199

Card Used in Farm Management Study in Livingston County, N. Y.

this card, it is possible to study a number of important relationships. There are included on it measures of size of business, efficiency of operation, production rates, and other factors which influence farm income. If it is desired to study the relation of income to size of business, it is possible to sort the cards by such measures as work units, crop acres, or number of cows, and to tabulate the income for each group.



RELATION OF SIZE OF BUSINESS TO LABOR INCOME WITH THE PRODUCTION INDEX HIGH

The linear regression line understates the importance of size of business when the rate of production is high. The joint regression line and the cross tabulation state the relationship correctly.

FIG. 200

If more refined analysis is needed, the sorting process may be carried one step further, to sub-sorting or double-sorting. By this method, one or more factors may be held constant while the effect of some other factor is being studied. Thus, it is possible by sub-sorting to determine the effect on income of labor efficiency at different levels of production rates.

The Livingston County study also illustrates an important application of tabulating machines in the proper interpretation of economic relationships.* Cross-tabulation or correlation tables, which may be obtained by double-sorting of punched-card data, tend to show situations correctly regardless of whether the relationships are linear, curvilinear, or joint. Mathematical correlation analysis, unless used very carefully, is easily misinterpreted. (See Fig. 200.) In this instance, linear correlation analysis gave an incorrect impression, whereas

* Warren, S. W., Multiple Correlation Analysis as Applied to Farm-Management Research, Cornell University Agricultural Experiment Station, Memoir 141. May 1932.

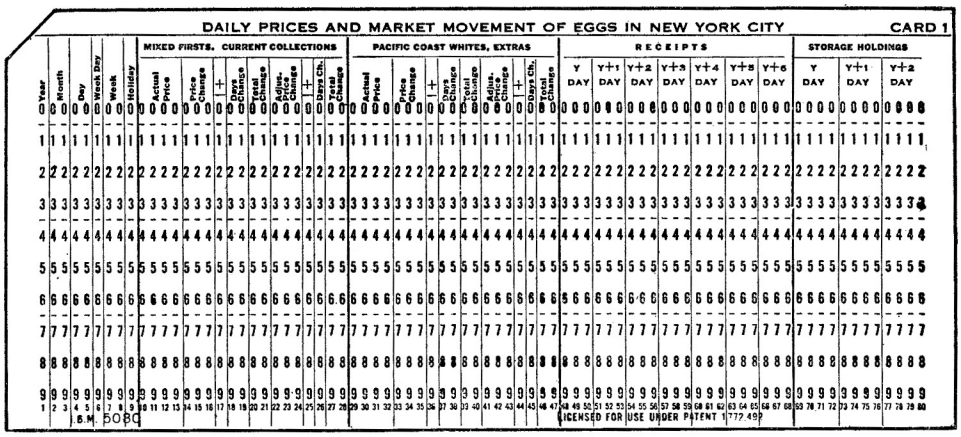


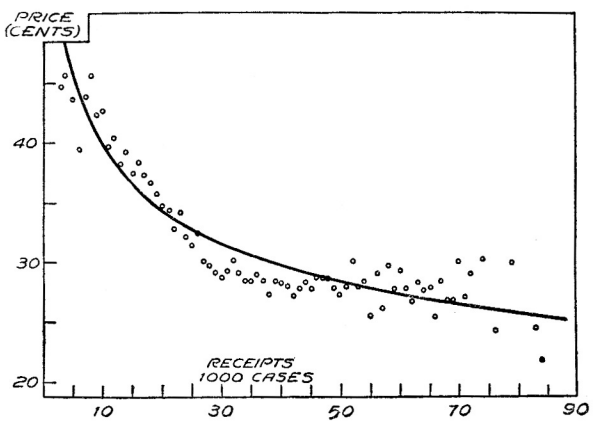
FIG. 201
Card Used in Supply-Price Study of Eggs

analysis based on joint correlation or cross-tabulation gave correct results.

Price Studies

Prices and price relationships may be often studied advantageously by use of Hollerith equipment. The principles involved are not essentially different from those previously mentioned. In any case where there is a large amount of data to be handled and numerous relationships to be studied, the tabulating machines are usually of assistance.

An investigation has been made of the relation of supply factors to prices of eggs.* One of the cards used is shown in Figure 201. In this study one of the problems was to determine the effect of daily receipts on daily prices of eggs; another problem was to analyze the effect of daily prices on later receipts. In each of these, it was necessary to make a great many different combinations of supply-price data, which would have been tedious and time-consuming by any other method. A graphical illustration of the effect of receipts of eggs on prices is shown in Figure 202.



RELATION OF DAILY RECEIPTS TO WHOLESALE PRICES OF EGGS (MIXED COLORS, FRESH GATHERED WESTERN FIRSTS), IN NEW YORK CITY, 1923 TO 1929.
Low receipts of eggs are accompanied by high prices, and high receipts by low prices. Low receipts affect prices more than high receipts.

FIG. 202
Chart from Results of Supply-Price Study of Eggs

An investigation was also made regarding the relation of price to quality of eggs. (See footnote, page 360.) In this study, various quality

* Vogt, Karl, Interrelationships of Daily Prices and Supply in the New York Egg Market, Cornell University Agricultural Experiment Station, Bulletin 596. April 1934.

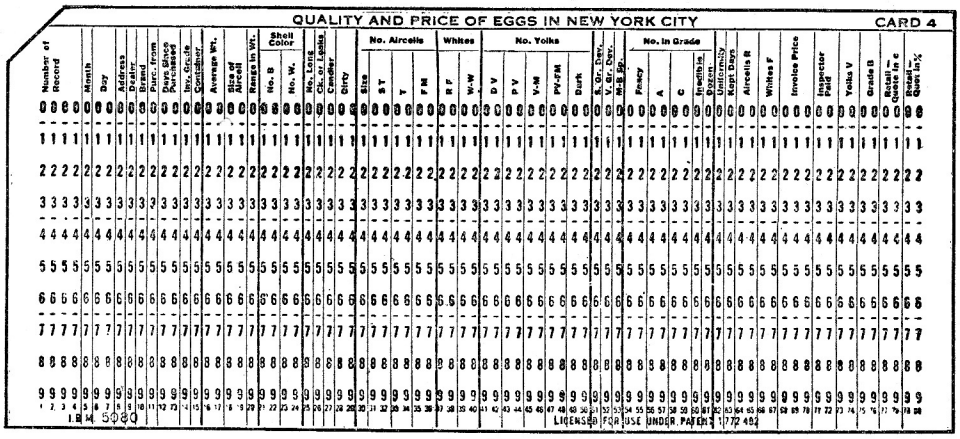
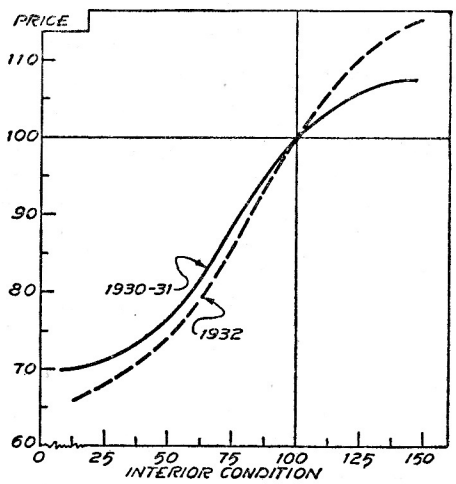


FIG. 203
Card Used in Price-Quality Study of Eggs

factors were measured and, together with price and other data, were punched on cards and analyzed by machine methods. Nearly 3000 records were included. Figure 203 shows one of the cards used in this study, while Figure 204 shows a chart taken from the publication and gives an indication of the results obtained.

In this study of price-quality relations of eggs the application of tabulating equipment to multiple correlation analysis is illustrated. The occasion for this type of analysis is indicated by the following quotation from the bulletin* (page 34):



RELATION OF THE COMPOSITE INDEX OF INTERIOR CONDITION TO THE RETAIL PRICE OF EGGS IN METROPOLITAN NEW YORK, 1930-31 AND 1932

When the composite index of interior condition was 50 per cent below average, the price was 24 per cent below average in 1930-31, compared with 26 per cent below in 1932.

FIG. 204
Chart from Results of Price-Quality Study of Eggs

"From the foregoing analysis, which has been based on cross-tabulation, it is apparent that consumer preferences for various quality factors are clearly reflected in the prices which are paid for eggs. The most important of these appear to be the size of the eggs, shell color, cleanness of the shells, the depth of air cell, and the interior condition of the eggs.

"In the cross-tabulation analysis, varying degrees of interrelationships were found to exist between these factors. The influence of these interrelationships on the premium or discount associated with a particular quality factor was eliminated by sorting and sub-sorting the data. In order to express the various relationships in more precise terms, and also to obtain a measure of

* Gans A. R., Relation of Quality to the Retail Price of Eggs in New York City, Cornell University Agricultural Experiment Station, Bulletin 597. April 1934.

the combined influence of the several factors on price, multiple correlations were computed."

The use of tabulating equipment in cases of this kind is to obtain certain totals or extensions which are necessary in the mathematical process of multiple correlation. With the tabulating machine it is usually possible, by a process of cumulative addition, to obtain these totals more quickly than by other methods.

Marketing Research

Marketing research frequently involves operations in which the punched-card method of analysis is of advantage. This is well illustrated by an investigation of the marketing of eastern grapes. For one section of the study,* which concerned wholesale marketing, it was felt that ordinary methods of tabulation were satisfactory. In the second section,** however, which dealt

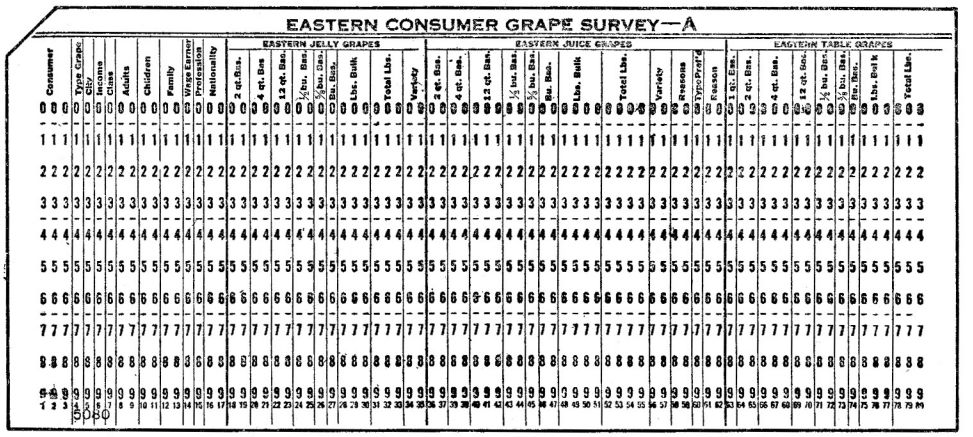


FIG. 205
Card Used in Marketing Study of Eastern Grapes

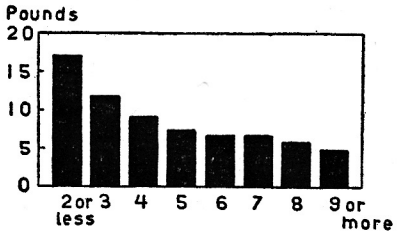
with retail distribution and consumer demand, it was decided, because of the nature and volume of the information involved, to use machine methods of tabulation.

This section required the analysis of about 2200 records of consumers' preferences and practices regarding eastern grapes. These records not only included data on types and amounts of grapes used and prices paid, but also information concerning nationality, income, occupation, size of family, and opinions of the consumers. For many of these, considerable detail was given; for instance, in the consideration of amounts of grapes used, the data were divided into seven different units of sale.

In the study of these consumer records, four different cards were used, one of which is shown in Figure 205. The procedure in analysis was largely to determine the use of grapes in relation to such factors as nationality, income,

* Rasmussen, M. P., Some Facts Concerning the Marketing of Eastern Grapes, Part 1. Competitive, Distribution, and Wholesale Marketing, Cornell University Agricultural Experiment Station, Bulletin 275. December, 1933.

** Rasmussen, M. P., Some Facts Concerning the Marketing of Eastern Grapes, Part II. Retail Distribution and Consumer Demand, Cornell University Agricultural Experiment Station, Bulletin 276. December 1933.



RELATION OF SIZE OF FAMILY TO PER CAPITA USE OF EASTERN GRAPES FOR JELLY IN PHILADELPHIA, CINCINNATI, AND CHICAGO
Per capita use declined with each increase in number of individuals per family.

FIG. 206
Chart from Results of Marketing Study of Eastern Grapes. (See text, page 361)

occupation and size of family. It was found, for instance, that the per capita use of grapes declined steadily with increase in the number of persons per family. Figure 206, taken from the bulletin, shows this situation graphically.

In the analysis of these data a fairly common, yet interesting, problem arose. It was found that the number of related factors was so large that it was impossible to punch them on one card. The solution used was to punch certain key factors on each of four cards. This made it possible to punch all of the related factors on four cards so that all desired relationships could be studied.

Land Utilization

Land utilization research as conducted in New York State involves the classification of land according to present and probable future uses.* Part of the procedure in this work has been to tabulate considerable data concerning soils, crops, roads, and the like, for the different classes of land. The original data ordinarily used in this work shows the number of acres of each crop or type of land-use and the number of acres of each soil type in every 10-acre section of land of the area surveyed. In order to find the type of land-use for each soil type, it is necessary to cross-multiply the land-use and soil-type data. This has been done both by ordinary methods and by punched-card, machine methods. In the latter case, the procedure is identical with that used to calculate the extensions for multiple correlation analysis.** The adaptation of the punched-card method to this phase of Land Utilization research was summarized by Dr. Lewis as follows* (page 35):

"Whether to use the card method or the method shown in..... depends on the time that each method requires and on the amount of information desired. It is not practical to determine the effect of elevation, slope, and class of road, on the use of land and the use of each soil type, except by card method.

"More time is saved by the card method where the land-class areas are small or where a higher percentage of the 10-acre squares have either two or more soil types or two or more uses of land. Where a 10-acre square has only one use or has only one soil type, the data on use of land can be tabulated by soil types.....without any multiplication."

Another application of Hollerith equipment in Land Utilization research

* Lewis, A. B., Methods Used in an Economic Study of Land Utilization in Tompkins County, New York, and in Other Similar Studies in New York, Cornell University Agricultural Experiment Station, Memoir 160. April 1934.

** EDITOR'S NOTE: The procedure above referred to is described in considerable detail in Dr. Brandt's paper on "Uses of the Progressive Digit Method," pp. 423 to 436 of this book.

is in connection with the tabulation of road types and telephone and electricity service in rural areas. Regarding this we quote again from Dr. Lewis* (page 56):

"In Chemung County, the number of buildings on each class of road and each class of electric line was tabulated by the use of Hollerith cards..... A card was punched for each road-and-electric-line unit. This showed the land class, the road class, the electric-line class, the mileage, and the number of farms and rural residences of different classes, on the unit of road. Electricity and telephone service were recorded."

Miscellaneous Applications

In addition to the above applications, tabulating equipment has been used at Cornell University for research in many other special fields of Agricultural Economics. In studies of taxation, part-time farming, agricultural credit, roadside marketing, cost of production, and other subjects it has been found advantageous to use the punched-card method. In all of these cases, the volume of data and the relationships to be studied were such that ordinary methods of tabulation would have been less efficient. It is felt that the machine method has a definite place in Agricultural Economics research.

*Cit. op.

PART VIII

Applications in Agricultural Research

CHAPTER III

Farm Management

By
FRANK JOYCE
Assistant Farm Management Specialist
Agricultural Extension Division, University of Tennessee

IT is only recently that the punched card method has been applied to farm management studies in Tennessee. The results we expect to obtain are well illustrated by Mr. Parsons in the preceding chapter. However, it may not be amiss to discuss briefly the type of farm management which we do, the purpose we have in mind, and the methods we follow.

The first step in our farm management work is to get county agents in the different counties to interest representative farms in keeping a complete account of the current year's farm business. At different times during the year such farmers are assisted by the county agent and the farm management department in keeping these records in a uniform, systematic way. At the end of the current year, these farm records are gone over carefully at the farm or in the county agent's office to see that they are prepared so as to give the desired information. After checking, the contents of the farm account books are summarized and transferred to a summary, or office sheet which is taken to headquarters and used for all office and analysis work. The completed account book is returned to the farmer, in whose possession it remains.

Briefly, such record contains all essential figures concerning the production and sale of crops; the production, purchase, and sale of livestock; all current farm expenses; depreciation and up-keep on buildings, fences and machinery; and also a beginning and ending inventory of all farm property and equipment and supplies. With this information, an income for each farm can be computed. There is always a great variation in the income made by different farms. To clearly bring home to the farmers and agents the reasons why certain farmers have made more money than others, the material taken from the farm account books is carefully analyzed in a number of different ways and a series of reports prepared. In addition to enabling the farmer to improve his individual status, the reports also form a background for the extension program for that county. Lastly, the information taken from these farm records assists specialists in related fields in the work which they conduct in the county through the medium of county and home demonstration agents.

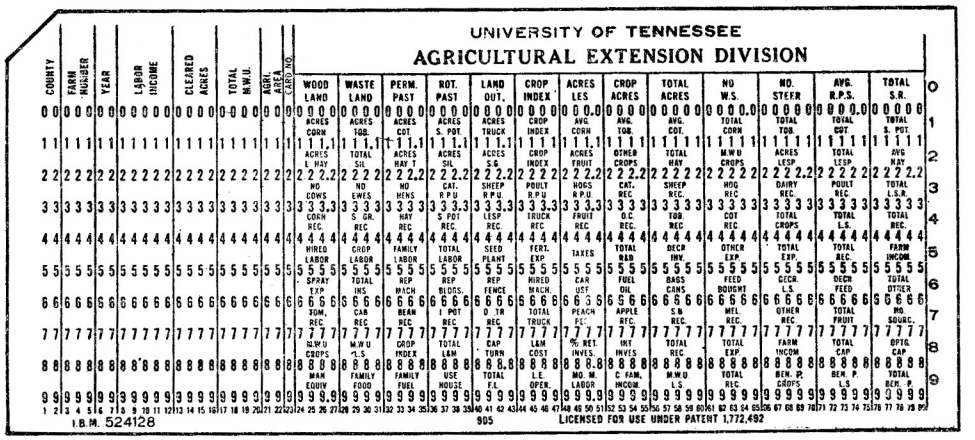


FIG. 207

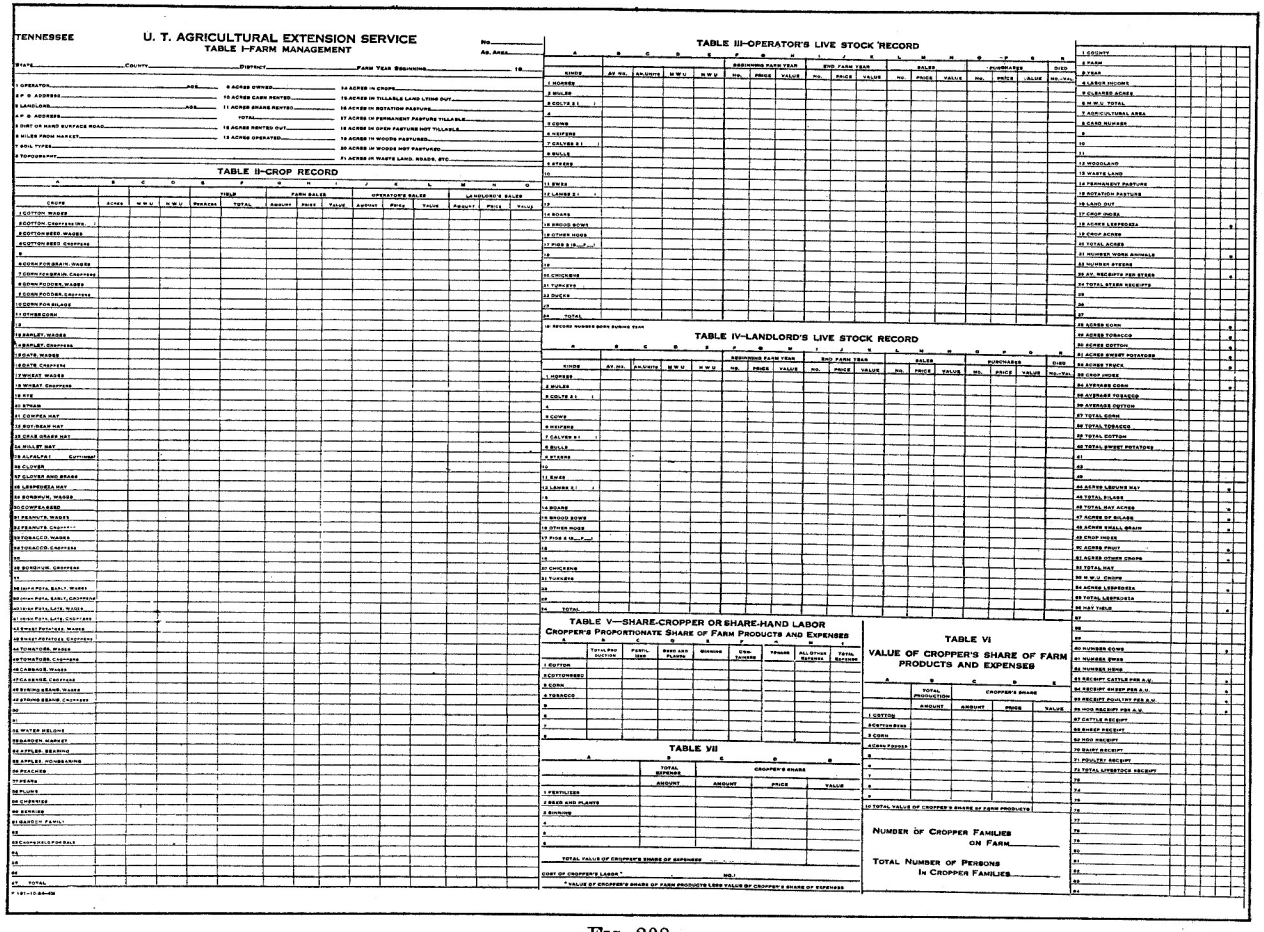
Tabulating Card to which data from Office Summary Sheet are transcribed

At the beginning of the current year, it was determined to make an attempt to expand farm management work in the state, both in the number of farm records kept and in the use of the information taken from such records. It was decided that more detailed data should be obtained from farmers than had been the practice in the past and that such information be incorporated into the extension program of the state to a greater degree than had previously been possible. Heretofore most of the calculating and analysis work had been done without the aid of calculating devices other than simple manually operated machines on which only adding could be done. We realized that if the farm management work was to be conducted on a large scale, some other method of handling the data would have to be found.

One of the greatest problems connected with this type of work was caused by the fact that reports for farmers and county agents could not be sent out until late in the year. Even then the lack of facilities for handling the information did not allow the reports to be as comprehensive as they should have been. The calculating in the office had to be kept at a minimum for the simple reason that time and equipment were lacking. For example, a county agent, on short notice, might want certain information concerning the records kept in his county. With our previous system it was frequently impossible to meet this time limit, while sometimes the desired information was altogether unobtainable.

With expansion in the farm management work, it was decided to get several calculating machines to be used in checking the office sheets on which the basic data are recorded and also to rent a set of Electric Tabulating Machines to do the tabulating necessary in preparing the material for use and for publication.

A modified office sheet (Figs. 208 and 209) was printed, and it is our hope that no tabulations will be required other than those which can be done automatically by the International Tabulating Machines. This change in office procedure is saving much time and work in preparing the data for use by the Extension Service and farmers. A tabulating card (Fig. 207) was printed



TENNESSEE

U. T. AGRICULTURAL EXTENSION SERVICE
TABLE I—FARM MANAGEMENT

TABLE II—CROP RECORD

TABLE III—OPERATOR'S LIVE STOCK RECORD

TABLE IV—LANDLORD'S LIVE STOCK RECORD

TABLE V—SHARE-CROPPER OR SHARE-HAND LABOR
CROPPER'S PROPORTIONATE SHARE OF FARM PRODUCTS AND EXPENSES

TABLE VI
VALUE OF CROPPER'S SHARE OF FARM PRODUCTS AND EXPENSES

TABLE VII

NUMBER OF CROPPER FAMILIES ON FARM

TOTAL NUMBER OF PERSONS IN CROPPER FAMILIES

FIG. 208
Modified Office Summary of Farm Account Book (Front)

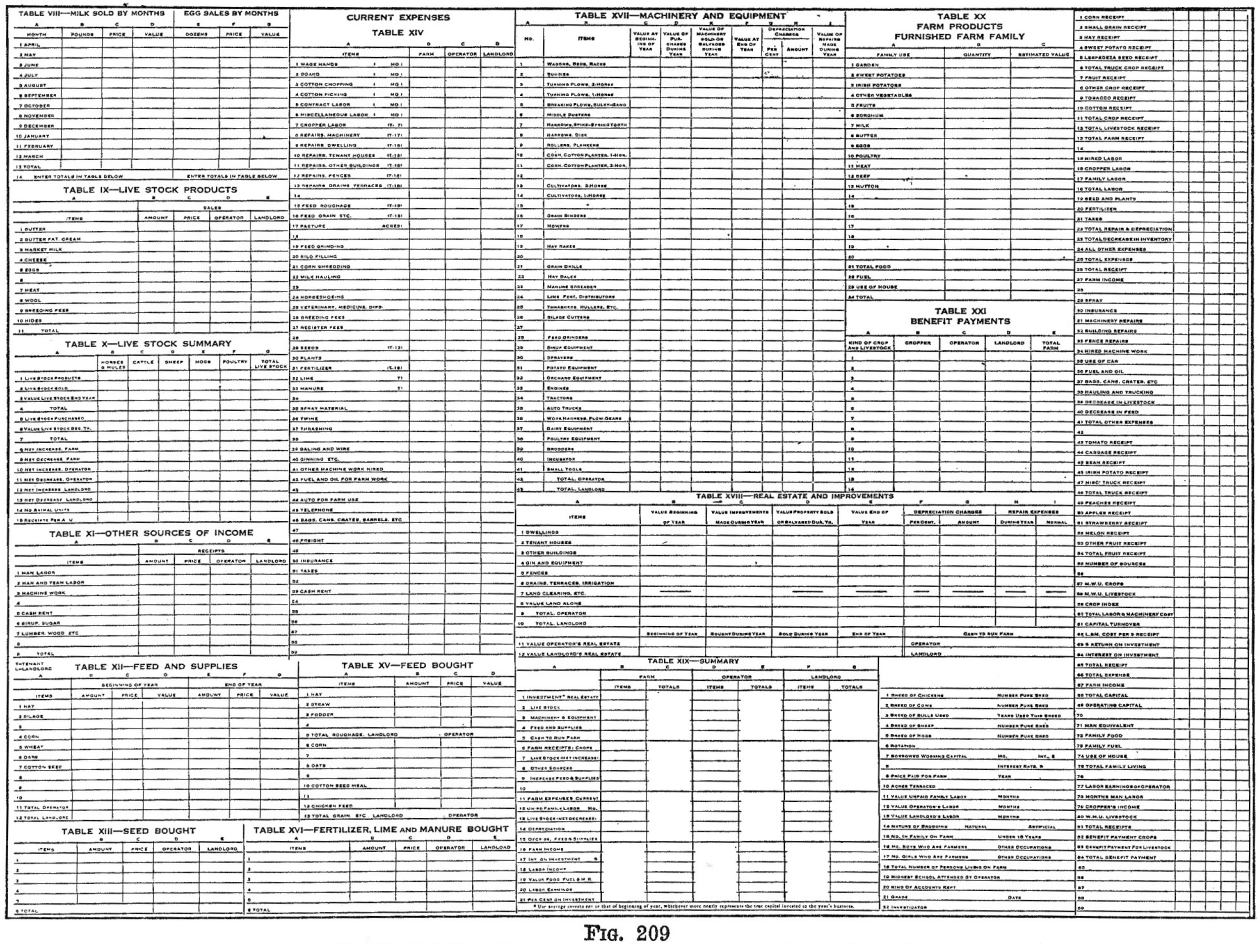


TABLE VIII—MILK SOLD BY MONTHS / EGG SALES BY MONTHS

MONTH	POUNDS	PRICE	VALUE	DOZENS	PRICE	VALUE
1 APRIL						
2 MAY						
3 JUNE						
4 JULY						
5 AUGUST						
6 SEPTEMBER						
7 OCTOBER						
8 NOVEMBER						
9 DECEMBER						
10 JANUARY						
11 FEBRUARY						
12 MARCH						
13 TOTAL						
14 ENTER TOTALS IN TABLE BELOW			ENTER TOTALS IN TABLE BELOW			

TABLE IX—LIVE STOCK PRODUCTS

ITEMS	SALES AMOUNT	SALES PRICE	SALES OPERATOR	SALES LANDLORD
1 BUTTER				
2 BUTTER FAT CREAM				
3 MARKET MILK				
4 CHEESE				
5 EGGS				
6				
7 MEAT				
8 WOOL				
9 BREEDING FEES				
10 HIDES				
11 TOTAL				

TABLE X—LIVE STOCK SUMMARY

	HORSES & MULES	CATTLE	SHEEP	HOGS	POULTRY	TOTAL LIVE STOCK
1 LIVE STOCK PRODUCTS						
2 LIVE STOCK SOLD						
3 VALUE LIVE STOCK END YEAR						
4 TOTAL						
5 LIVE STOCK PURCHASED						
6 VALUE LIVE STOCK DEC. 31						
7 TOTAL						
8 NET INCREASE, FARM						
9 NET EXCHANGE, FARM						
10 NET INCREASE, OPERATOR						
11 NET DECREASE, OPERATOR						
12 NET INCREASE, LANDLORD						
13 NET DECREASE, LANDLORD						
14 NO ANIMAL UNITS						
15 EQUIVALENT FOR A. U.						

TABLE XI—OTHER SOURCES OF INCOME

ITEMS	RECEIPTS AMOUNT	RECEIPTS PRICE	RECEIPTS OPERATOR	RECEIPTS LANDLORD
1 MAN LABOR				
2 MAN AND TEAM LABOR				
3 MACHINE WORK				
4				
5 CASH RENT				
6 SYRUP, SUGAR				
7 LUMBER, WOOD, ETC				
8				
9 TOTAL				

TABLE XII—FEED AND SUPPLIES

ITEMS	BEGINNING OF YEAR AMOUNT	BEGINNING OF YEAR PRICE	BEGINNING OF YEAR VALUE	END OF YEAR AMOUNT	END OF YEAR PRICE	END OF YEAR VALUE
1 HAY						
2 SILAGE						
3						
4 CORN						
5 WHEAT						
6 OATS						
7 COTTON SEED						
8						
9						
10						
11 TOTAL OPERATOR						
12 TOTAL LANDLORD						

TABLE XIII—SEED BOUGHT

ITEMS	AMOUNT	PRICE	OPERATOR	LANDLORD
1				
2				
3				
4				
5				
6 TOTAL				

CURRENT EXPENSES

TABLE XIV

ITEMS	FARM	OPERATOR	LANDLORD
1 HAND HANDS	MO.		
2 BOARD	MO.		
3 COTTON CHOPPING	MO.		
4 COTTON PICKING	MO.		
5 CONTRACT LABOR	MO.		
6 MISCELLANEOUS LABOR	MO.		
7 CARPTER LABOR	(P. 71)		
8 REPAIRS, MACHINERY	(P. 17)		
9 REPAIRS, DWELLING	(P. 18)		
10 REPAIRS, TENANT HOUSES	(P. 28)		
11 REPAIRS, OTHER BUILDINGS	(P. 19)		
12 REPAIRS, FENCES	(P. 18)		
13 REPAIRS, DRAINS TERRACES	(P. 18)		
14			
15 FEED, ROUGHAGE	(P. 19)		
16 FEED, GRAIN, ETC.	(P. 19)		
17 PASTURE	ACRES		
18			
19 FEED GRINDING			
20 SILO FILLING			
21 CORN SHREDDING			
22 MILK HAULING			
23			
24 HORSESHOEING			
25 VETERINARY, MEDICINE, DIPS			
26 BREEDING FEES			
27 REGISTER FEES			
28			
29 SEEDS	(P. 21)		
30 PLANTS			
31 FERTILIZER	(P. 18)		
32 LIME	(P. 21)		
33 MANURE	(P. 21)		
34			
35 SPRAY MATERIAL			
36 TWINE			
37 TWINE AND WIRE			
38 BALING AND WIRE			
39 GINNING, ETC.			
40 OTHER MACHINE WORK HIRED			
41 FUEL AND OIL FOR FARM WORK			
42			
43 AUTO FOR FARM USE			
44 TELEPHONE			
45 BOOKS, CANS, CRATES, BARRELS, ETC.			
46			
47 FREIGHT			
48			
49 INSURANCE			
50 TAXES			
51			
52 CASH RENT			
53			
54			
55			
56			
57			
58			
59			

TABLE XV—FEED BOUGHT

ITEMS	AMOUNT	PRICE	VALUE
1 HAY			
2 STRAW			
3 FODDER			
4			
5 TOTAL ROUGHAGE, LANDLORD			OPERATOR
6 CORN			
7			
8 OATS			
9			
10 COTTON SEED MEAL			
11			
12 CHICKEN FEED			
13 TOTAL GRAIN, ETC.	LANDLORD		OPERATOR

TABLE XVI—FERTILIZER, LIME AND MANURE BOUGHT

ITEMS	AMOUNT	PRICE	OPERATOR	LANDLORD
1				
2				
3				
4				
5				
6 TOTAL				

TABLE XVII—MACHINERY AND EQUIPMENT

NO.	ITEMS	VALUE AT BEGINNING OF YEAR	VALUE OF PURCHASES DURING YEAR	VALUE OF SALES OR SALVAGE DURING YEAR	VALUE AT END OF YEAR	DEPRECIATION CHARGED PER CENT	DEPRECIATION CHARGED AMOUNT	VALUE OF REPAIRS MADE DURING YEAR
1	WAGONS, BODS, RACKS							
2	SURREY							
3	TURNING PLOWS, SINGLE							
4	TURNING PLOWS, DOUBLE							
5	BREAKING PLOWS, SULEY-DISC							
6	MIDDLE BUSTERS							
7	HARROWS, SPIKE-TOOTH & SPRING-TOOTH							
8	HARROWS, DISC							
9	ROLLERS, PLANKERS							
10	CORN, COTTON PLANTERS, 1-ROW							
11	CORN, COTTON PLANTERS, 2-ROW							
12								
13	CULTIVATORS, 2-ROWS							
14	CULTIVATORS, 1-ROWS							
15								
16	GRAIN BINDERS							
17	MOWERS							
18								
19	HAY RAKES							
20								
21	GRAIN DRILLS							
22	HAY BALES							
23	MANURE SPREADERS							
24	LIME, FERT. DISTRIBUTORS							
25	TRANSPLANTERS, HILLERS, ETC.							
26	SILAGE CUTTERS							
27								
28	FEED GRINDERS							
29	DAIRY EQUIPMENT							
30	SPRAYERS							
31	POTATO EQUIPMENT							
32	ORCHARD EQUIPMENT							
33	SURVEYS							
34	TRACTORS							
35	AUTO TRUCKS							
36	MOWS, HARVESTERS, PULL-OTHERS							
37	SILAGE EQUIPMENT							
38	POULTRY EQUIPMENT							
39	BROODERS							
40	INCUBATORS							
41	SMALL TOOLS							
42	TOTAL, OPERATOR							
43	TOTAL, LANDLORD							

TABLE XVIII—REAL ESTATE AND IMPROVEMENTS

ITEMS	VALUE BEGINNING OF YEAR	VALUE IMPROVEMENTS MADE DURING YEAR	VALUE PROPERTY SOLD OR BALANCED DUR. YR.	VALUE END OF YEAR	DEPRECIATION CHARGED PER CENT.	DEPRECIATION CHARGED AMOUNT	REPAIR EXPENSES DURING YEAR	REPAIR EXPENSES NORMAL
1 DWELLINGS								
2 TENANT HOUSES								
3 OTHER BUILDINGS								
4 GIN AND EQUIPMENT								
5 FENCES								
6 DRAINS, TERRACES, IRRIGATION								
7 LAND CLEARING, ETC.								
8 VALUE LAND ALONE								
9 TOTAL, OPERATOR								
10 TOTAL, LANDLORD								
	BEGINNING OF YEAR	BOUGHT DURING YEAR	SOLD DURING YEAR	END OF YEAR		CASH TO RUN FARM		
11 VALUE OPERATOR'S REAL ESTATE						OPERATOR		
12 VALUE LANDLORD'S REAL ESTATE						LANDLORD		

TABLE XIX—SUMMARY

	FARM ITEMS	FARM TOTALS	OPERATOR ITEMS	OPERATOR TOTALS	LANDLORD ITEMS	LANDLORD TOTALS
1 INVESTMENT* REAL ESTATE						
2 LIVE STOCK						
3 MACHINERY & EQUIPMENT						
4 FEED AND SUPPLIES						
5 CASH TO RUN FARM						
6 FARM RECEIPTS: CROPS						
7 LIVE STOCK (NET INCREASE)						
8 OTHER SOURCES						
9 EXPENSES PAID & SUPPLIES						
10						
11 FARM EXPENSES (CURRENT)						
12 WAGES PAID—CASH	NO.					
13 LIVE STOCK (NET DECREASE)						
14 DEPRECIATION						
15 DEER KIL. FEEDS SUPPLIES						
16 FARM INCOME						
17 INT. ON INVESTMENT 6						
18 LABOR INCOME						
19 VALUE FOOD FURN'D BY M. R.						
20 LABOR EARNINGS						
21 PER CENT ON INVESTMENT						

* Use average invest'mt or that of beginning of year, whichever more nearly represents the use capital invested in the year's business.

TABLE XX
FARM PRODUCTS FURNISHED FARM FAMILY

FAMILY USE	QUANTITY	ESTIMATED VALUE
1 GARDEN		
2 SWEET POTATOES		
3 IRISH POTATOES		
4 OTHER VEGETABLES		
5 FRUITS		
6 SORGHUM		
7 MILK		
8 BUTTER		
9 EGGS		
10 POULTRY		
11 MEAT		
12 BEEF		
13 MUTTON		
14 PORK		
15		
16		
17		
18		
19		
20		
21 TOTAL FOOD		
22 FUEL		
23 USE OF HOUSE		
24 TOTAL		

TABLE XXI
BENEFIT PAYMENTS

KIND OF CROP AND LIVESTOCK	CROPPER	OPERATOR	LANDLORD	TOTAL FARM
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				

1 CORN RECEIPT
2 SMALL GRAIN RECEIPT
3 HAY RECEIPT
4 SWEET POTATO RECEIPT
5 LESPEDEZA SEED RECEIPT
6 TOTAL TRUCK CROP RECEIPTS
7 FRUIT RECEIPTS
8 OTHER CROP RECEIPT
9 TOBACCO RECEIPT
10 COTTON RECEIPT
11 TOTAL CROP RECEIPT
12 TOTAL LIVESTOCK RECEIPT
13 TOTAL FARM RECEIPT
14
15 HIRED LABOR
16 CROPPER LABOR
17 FAMILY LABOR
18 TOTAL LABOR
19 SEED AND PLANTS
20 FERTILIZER
21 TAXES
22 TOTAL REPAIR & DEPRECIATION
23 TOTAL DECREASE IN INVENTORY
24 ALL OTHER EXPENSES
25 TOTAL EXPENSES
26 TOTAL RECEIPT
27 FARM INCOME
28
29 SPRAY
30 INSURANCE
31 MACHINERY REPAIRS
32 BUILDING REPAIRS
33 FENCE REPAIRS
34 HIRED MACHINE WORK
35 USE OF CAR
36
37 FUEL AND OIL
38 BAGS, CANS, CRATES, ETC
39 HAULING AND TRUCKING
40 INCREASE IN LIVESTOCK
41 DECREASE IN FEED
42 ALL OTHER EXPENSES
43
44 TOMATO RECEIPT
45 CABBAGE RECEIPT
46 BEAN RECEIPT
47 IRISH POTATO RECEIPT
48 MISC. TRUCK RECEIPT
49 TOTAL TRUCK RECEIPT
50 PEACHES RECEIPT
51 APPLES RECEIPT
52 STRAWBERRY RECEIPT
53 MELON RECEIPT
54 OTHER FRUIT RECEIPT
55 TOTAL FRUIT RECEIPT
56 NUMBER OF SOURCES
57
58 M. M. U. CROPS
59 M. M. U. LIVESTOCK
60 CROP INDEX
61 TOTAL LABOR & MACHINERY EXP.
62 CAPITAL TURNOVER
63 L. & M. COST PER $ RECEIPT
64 % RETURN ON INVESTMENT
65 % INTEREST ON INVESTMENT
66 TOTAL RECEIPT
67 TOTAL EXPENSES
68 FARM INCOME
69 TOTAL CAPITAL
70
71 MAN EQUIVALENT
72 FAMILY FOOD
73 FAMILY FUEL
74 USE OF HOUSE
75 TOTAL FAMILY LIVING
76
77 LABOR EARNINGS OPERATOR
78 MONTHS MAN LABOR
79 CROPPER'S INCOME
80 M. M. U. LIVESTOCK
81 TOTAL RECEIPTS
82 BENEFIT PAYMENT CROPS
83 BENEFIT PAYMENT FOR LIVESTOCK
84 TOTAL BENEFIT PAYMENT
85
86
87
88
89

FARM ACCOUNT BOOK

1 BREED OF CHICKENS	NUMBER PURE BRED		
2 BREED OF COWS	NUMBER PURE BRED		
3 BREED OF BULLS USED	YEARS USED THIS BREED		
4 BREED OF SHEEP	NUMBER PURE BRED		
5 BREED OF HOGS	NUMBER PURE BRED		
6 MOTHER			
7 BORROWED WORKING CAPITAL	AMT.	INT. %	
8	INTEREST RATE %		
9 PRICE PAID FOR FARM	YEAR		
10 ACRES TERRACED			
11 VALUE UNPAID FAMILY LABOR	MONTHS		
12 VALUE OPERATOR'S LABOR	MONTHS		
13 VALUE LANDLORD'S LABOR	MONTHS		
14 NATURE OF BREEDING	NATURAL	ARTIFICIAL	
15 NO. IN FAMILY ON FARM	UNDER 16 YEARS		
16 NO. BOYS WHO ARE FARMERS	OTHER OCCUPATIONS		
17 NO. GIRLS WHO ARE FARMERS	OTHER OCCUPATIONS		
18 TOTAL NUMBER OF PERSONS LIVING ON FARM			
19 NUMBER SCHOOL ATTENDED BY CHILDREN			
20 KIND OF ACCOUNTS KEPT			
21 SHEETS	DATE		
22 INVESTIGATOR			

FIG. 209
Modified Office Summary of Farm Account Book (Back)

on which the farm management data are punched. To simplify the punching, the new office sheet has in the margin a place for listing all essential information. The headings on this margin correspond exactly to those on the tabulating cards. Incidentally, it will be necessary to use ten cards for each farm record in order to punch practically all the useful data.

Cards are punched as fast as the sheets are sent to the office and checked, and as soon as all the records in a given county are completed, a summary for that county can be prepared in a short time by running the cards through the sorting and tabulating machines. By doing this, we can get the information back to the county agent and the farmer in a shorter time so that it can be put in use at the earliest possible date.

By having this punched card equipment we can work out many more factors in the analysis of a farm that we have been able to do in the past. In the study of these farm management records nearly all of the factors are related to the income from the farm and in some cases factors are related to each other. By sorting the cards on corn yield, for instance, and running them through the tabulating machine, the effect of different corn yields on income can be established. At the same time, the acres of corn and the total production of corn can be tabulated along with the yields per acre and the income from the farm. A multiplicity of relations can be made with the tabulating machine and the work can be done in a minimum length of time.

With this equipment we hope to devote the time formerly used for manual computation to the collection of the material in the different counties and to its preparation for publication. With its help we expect to make more calculations and work out more relations than ever before, and do it in a shorter time and without causing interference with other important phases of our work.

PART VIII

Applications in Agricultural Research

CHAPTER IV

Forestry

By

PHILIP R. WHEELER

*Assistant Forest Economist, Southern Forest Experiment Station, United States Department of Agriculture**

THE uses of electric tabulating machines in forestry research have long been recognized. Many applications have been developed, and, as the demands for more comprehensive analyses of known facts and for additional detail are increasing, still further development may be looked for.

A good example of how the punched card method may be applied to a particular problem is its use in connection with the *Southern Forest Survey*. This survey is organized to make a timber inventory of 70,000,000 acres a year. Reports are made on units varying from 4,000,000 to 11,000,000 acres. Each report must include: (1) area of land in forest and non-forest conditions; (2) stand tables showing the distribution of volumes among the several tree diameter classes; (3) estimates of board-foot and cubic-foot volumes; (4) estimates of turpentine-producing pine timber stands; (5) an estimate of growth to aid in the prediction of future yields; and (6) a statement of the magnitude of sampling errors.

The problems imposed by these six major compilations and calculations are handled most effectively by the punched-card method.

Area

The sample plots from which the original data are obtained are established systematically so that each plot represents a sample of 800 acres. Land area calculations for breakdowns of any of the coded qualifying information (see following page) are all based on sorts of the master cards (See Fig. 210) punched for each plot. The counting sorter is best suited for this purpose because only one sort is necessary to count the number of cards in each code in a card column. Figure 212 shows the forest plot field form, from which the forest plot master card is punched.

Stand Tables

The construction of composite stand tables, heretofore a tedious problem for

* While Mr. Wheeler is not connected with a University it was felt nevertheless that his paper had a definite place in this book as analogous applications exist in many Schools of Forestry.

CODES USED ON FOREST PLOT FIELD FORM

STATE CODE NUMBERS

1. Mississippi
2. Louisiana
3. Arkansas
4. Texas
5. Alabama
6. Georgia
7. Florida
8. South Carolina
9. North Carolina
10. Tennessee
11. Missouri
12. Virginia

COUNTY CODE NUMBERS

Coded as per state blue prints.

FOREST CONDITIONS

1. Old growth—uncut
2. Old growth—partly cut
3. Second growth—sawlog size—uncut
4. Second growth—sawlog size—partly cut
5. Second growth—under sawlog size—uncut
6. Second growth—under sawlog size—partly cut
7. Clear cut
8. Reproduction
9. Non-commodity
10. Fire killed

FOREST TYPES

1. Longleaf pine
2. Longleaf—slash pine
3. Slash pine
4. Slash pine—cypress
5. Turpentine pine—hardwoods
6. Non-turpentine pine hardwoods
7. Bottomland and swamp hardwoods
8. Upland hardwoods
9. Scrub oak scrub hardwoods
10. Scrub pine
11. Cypress—tupelo
12. Non-turpentine pine

TOPOGRAPHIC DESCRIPTIONS

1. Flatwoods
2. Rolling uplands
3. Swamps, bays, ponds and branch heads
4. River bottoms
5. Sand dunes

VOLUME INDEX

1. 250 bd. ft., Scribner Dec. C grades 1 and 2
2. Less than 250 bd. ft., grades 1 and 2

FIRE DAMAGE

1. No indication of fire
2. Fire indication present but no apparent damage
3. Fire present and damage light
4. Fire present and damage medium
5. Fire present and damage heavy

TURPENTINE HISTORY

1. Round timber
2. Being worked for first set of faces
3. Back cupped
4. Idle
5. Worked out

TYPE OF CUP

1. Clay, aluminum, or zinc
2. Other metal
3. Cut boxes

REPRODUCTION DISTRIBUTION

1. Complete, 75% to 100% occupied by seedlings
2. Partial, 25% to 75% occupied by seedlings
3. Scanty, 5% to 25% occupied by seedlings
4. None, less than 5% occupied by seedlings

REPRODUCTION DENSITY

1. Seedlings 6 ft. or less from each other
2. Seedlings more than 6 ft., less than 14 ft. apart.
3. Seedlings more than 14 ft., less than 25 ft. apart
4. Seedlings more than 25 ft. apart

REPRODUCTION SPECIES

Same as tally species group codes.

SITE INDEX

PINE—Growth in 50 years for species indicated

HARDWOOD—1. Good; 2. Fair; 3. Poor

BROWN SPOT

1. Unimportant—less than 33% of seedlings show at least 10% of the foliage infected
2. Medium—33% to 65% of seedlings show 10% or more of the foliage infected
3. Serious—66% or more of the seedlings, show 10% or more of the foliage infected

HOG DAMAGE

1. Hog damage absent
2. Hog damage present

STUMPS

1. Present or merchantable; 2. Future
   1. 7 stumps per ¼ acre
   2. 4 stumps per ¼ acre
   3. 2 stumps per ¼ acre
   4. Less than 2 stumps per ¼ acre
   5. Pulled

CULL AGENCIES

1. Fire; 2. Rot; 4. Insects
7. Fork, crook, large limbs
8. Turpentine work
9. Undetermined

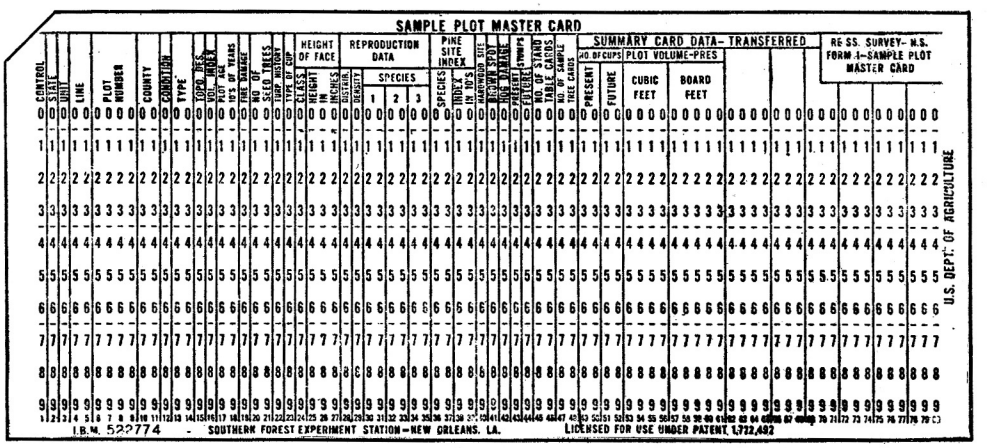


FIG. 210

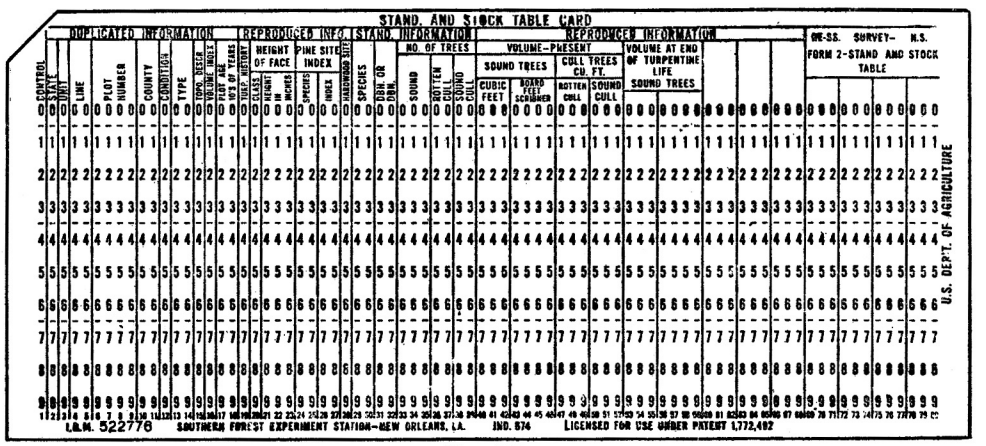


FIG. 211

forest research workers, is mechanized by punching a stand table card (Fig. 211) for each species group—diameter class combination tallied on the field form (Fig. 212).

These cards permit composite stand table tabulation for any descriptive qualification by sorting the cards to the required combination, further sorting them into diameter class—species groups, wiring diameter class to minor control and species group to major control, and tabulating the composite stand table as in tabulation Fig. 213. A count of the plots included in the stand description readily enables a computation of average acre stand tables from the above tabulations.

Regional Volume

Multiple tree volume tables may be punched as master volume table cards. A listing serves to check these (Fig. 214). The volume table master cards are then sorted ahead of the stand table cards, sorting by number of trees, diameter classes and species groups. Each volume table master card will then lead all cards of similar description. The entire group of cards are then gang-

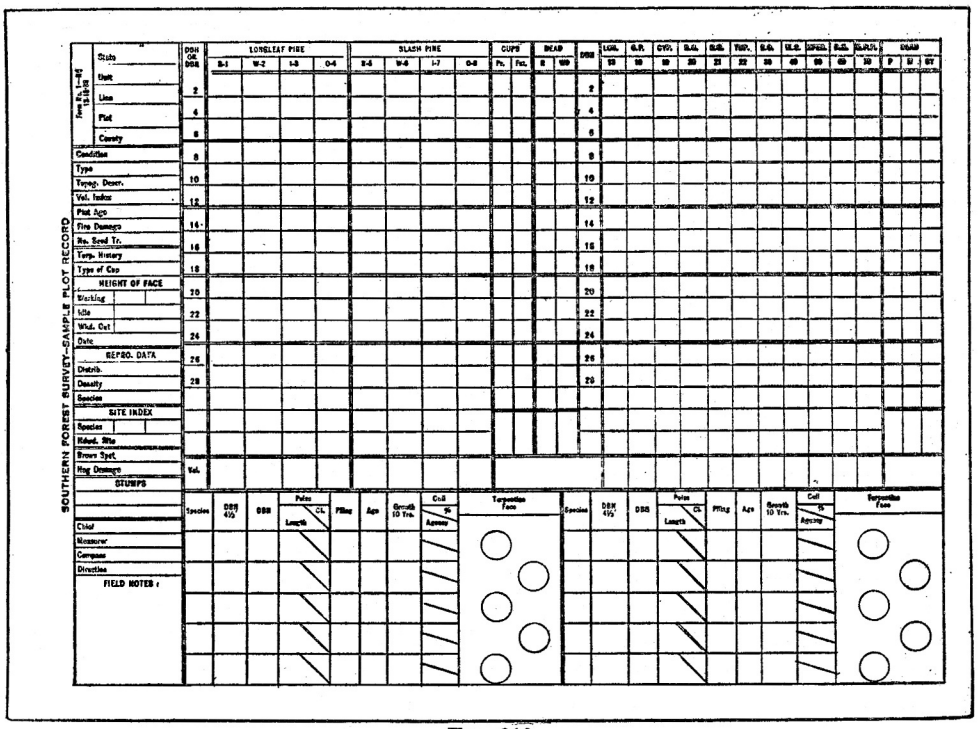


FIG. 212

Forest Plot Field Form

Composite Stand and Stock Table

Basis - 323 Forest Plots.

Species (Cols. 29&30)	Diameter Class (Cols. 31&32)	Number of Sound Trees (Cols.33-35)	Volume in Bd.Ft. (Cols. 43-48)	Total Number of Trees.	Total Volume in Board Feet.
2	06	30			
2	08	109			
2	10	92	2576		
2	12	54	2970		
2	14	11	1045		
2	16	1	148		
2	22	1	386	298*	7126*

FIG. 213

Tabulated Stand and Stock Table

Multiple Volume Table
Listed from volume master cards for reference and check.

Diameter Class	No. Trees	Volume Bd.Ft.	No. Trees	Volume Bd.Ft.	No. Trees	Volume Bd.Ft.	No. Trees	Volume Bd.Ft.	No. Trees	Volume Bd.Ft.	No. Trees	Volume Bd. Ft.
10	01	0028	02	0056	03	0084	04	0112	05	0140	06	0168
12	01	0055	02	0110	03	0165	04	0220	05	0275	06	0330
14	01	0095	02	0190	03	0285	04	0380	05	0475	06	0570
16	01	0148	02	0296	03	0444	04	0592	05	0740		
18	01	0210	02	0420	03	0630	04	0840				
20	01	0278	02	0556	03	0834	04	1112				
22	01	0386										

FIG. 214

punched in a comparing reproducer;* i. e., the volumes associated with the punched number of trees of each diameter class—species group are punched into the stand table cards in the proper field, becoming, during the operation, stand and stock table cards. Tabulations of volume by diameter class—species groups, and other qualifying information, may be run similarly or in conjunction with the composite stand tables (Fig. 213). Regional volumes are merely totals of the several composite stand tables, multiplied by the necessary area factor.

Turpentine Croppage

A canvass of the turpentine stills is made by an experienced man, who fills out the questionnaire shown in Fig. 215. The greater share of this information is coded and punched on cards. Runs and tabulations similar to those used by the Bureau of the Census are prepared, principal among these being a tabulation of the turpentine croppage now in operation.

Growth

The volume growth in ten years is reproduced into the sample tree cards (Fig. 216) from growth master cards. The sample tree cards are arranged in order by 1/10 inch radial growth classes, diameter classes, and species. Growth master cards are sorted in containing volume growth amounts read for each 1/10 inch radial growth class—diameter class from volume table curves. The volume growths are then gang-punched by running the cards through the reproducer. A tabulation of the volume growth associated with all the sample trees in each diameter class is made. The exact ratio of tallied trees to sample trees is found and applied to the sample tree growth to find the growth of the tallied trees. A mortality deduction is made on the tallied tree growth and the volume growth remaining is expressed as a net growth per cent of the present volume.

* EDITOR'S NOTE: See illustration on page 14, Fig. 13.

Form #12
(6/26/34)

FOREST SURVEY - GUM NAVAL STORES

REPORT NUMBER _____ Date _____

State _____ Unit _____ County _____

Topog. Site _____ Still Location _____

Name of Place _____ P.O. Address _____

Owner _____ P.O. Address _____

Kind of Operation _____
(Operator; gum producer; custom stiler; farmer)

ACREAGE:

1934-35 OWNED		LEASED	
Acres _____	No. faces _____	Acres _____	No. Faces _____
Working _____		Working _____	
Resting _____		Resting _____	
Perm. abd. _____		Perm. abd. _____	
Non-turpentine _____		Non-turpentine _____	
% Slash _____	% Longleaf _____	Total Cups _____	

Remarks: _____

AGE	CROPPAGE 1934-35	CROPPAGE 1933-34
1st year _____		
2nd year _____		
3rd year _____		
4th year _____		
5th year _____		
6th year and up		
TOTAL		

PRODUCTION: Season ending March 30, 1934.

No. 50 Gal. Bbls. Spirits _____ No. 500-lb. Bbls. Rosin _____

Spirits: From Leased and owned _____ Bbls.; from bought gum _____ Bbls.;

gum stilled for others _____ Bbls. Remarks: _____

Average yield per crop for place _____ units for _____ streaks.

Cup count, hung _____ count raised _____ Ave. ann. reduction _____

Class of timber _____
(Old growth; second growth; average size and thrift)

Kind of Cups		Kind of Tins	
_____	_____%	_____	_____%
_____	_____%	_____	_____%
_____	_____%	_____	_____%

Stilling Practice

Setting _____ Stilling method _____

Woods Work

Chipping: Depth _____ Height _____ Pulling: Depth _____ Height _____
Avg. height season work: Chipping _____ Ins. Pulling _____ Ins.
Min. D.B.H. round timber cupped _____ Ins. Dipping frequency _____
No. of cups per tree 8" to 10" _____; 11" to 13" _____; 14" up _____
Cup-raising period _____ Use cup covers? _____
Trend toward improved practices: _____

Fire Control: Rake and Burn _____ Rake and patrol _____
Organized F.C. (No raking) _____

General Data:

Average rest between cuppings _____ Yrs.

Future of place ; Maintaining present croppage? _____

Increasing croppage? _____

Use of worked-out trees _____
(% of use - Sawtimber, poles, ties, pulpwood, etc.)

Fuelwood used annually:

For still and pump (green _____ cords, dead _____ cords) For quarters (green _____ cords, dead _____ cords)

Engaged in farming also? _____ Connection _____

Remarks: _____
(Tree plantings, thinning, forestry measures other than F.C.)

FIG. 215

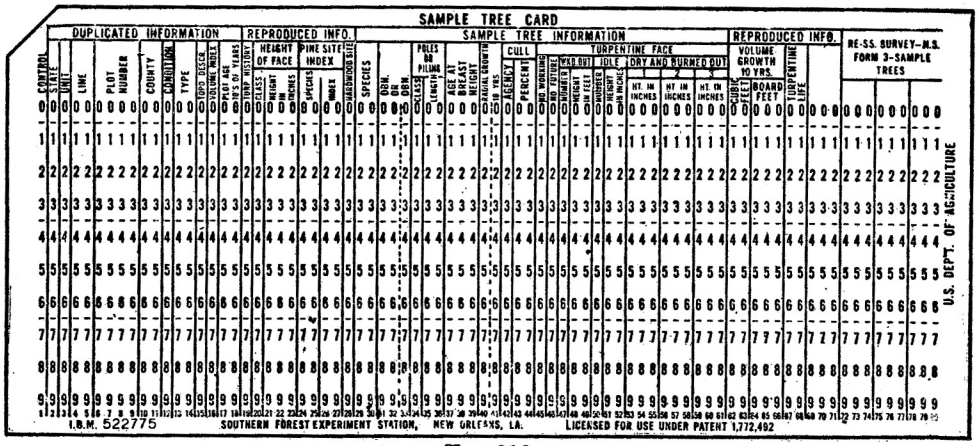


FIG. 216

Accuracy Figures

The volumes punched on the stand table cards for each plot are accumulated to arrive at individual plot volumes. These may be summary-punched simultaneously with tabulation; i.e., as the volume results of each plot number are printed, the same figures are transferred to a punch card in the summary punch, together with the plot number and the line number. The total plot volume information is later reproduced into the sample plot master cards by means of the comparing reproducer. By sorting the master cards in sequence by plot volume, frequency tables are built for standard error of volume calculations. An example of such a frequency table is found in the following table:

Volume Class Board feet	Card Count No. of Plots	Volume Class Board feet	Card Count No. of Plots	Volume Class Board feet	Card Count No. of Plots
0 - 99	174	500 - 599	6	1000 - 1099	0
100 - 199	68	600 - 699	4	1100 - 1199	0
200 - 299	32	700 - 799	4	1200 - 1299	2
300 - 399	16	800 - 899	3		
400 - 499	10	900 - 999	4	Grand Total Cards. .	323

The basic data for area accuracy computations are compiled by separating the plot master cards into twenty replications. The plot master cards are arranged in sequence by plot and line number. In a two column field at the extreme right of the first card, 1 is punched; in the second card a 2 is punched in the corresponding column; in card 3, a 3 is punched, etc., until the 20th card is punched. In the corresponding column of the 21st card a 1 is punched, in the 22nd a 2 is punched, etc. This process is repeated for each succeeding group of 20 cards. A sort on this field arranges the cards into the twenty replications, in effect "dealing" all the master cards into twenty "hands." Counts are compiled of the master cards in similar categories of each of the twenty replications, and from them are calculated the standard error of area.

For the forest research worker who has much use for setting up replications of his data for standard deviation calculations the problem may be easily handled through the use of the "collating device" on a sorter. This

device automatically "deals" the cards, in any number of "hands" up to 12, without reference to punched information. A greater number of replications may be made by dealing each of the first 12 groups into two or more additional hands again.

Dr. Halbert L. Dunn's method of geometric coding, enabling several times the usual amount of data to be punched on a card, deserves the attention of research men. Where, by the ordinary method of punching, only 22 to 40 two or three digit items may be placed on an 80 column card, Dr. Dunn's coding will allow room for 80 to 160 similar items. The system works best where a printing counting sorter is installed.

To sum up:

1. Large quantities of data may be handled within a minimum of time.
2. Composite stand tables may be built subject to check at every step, an impossibility with the manual method of dot tally transfer.
3. By applying volume tables to the tree tally cards and making the necessary tabulations, individual plot volumes and regional volumes may be obtained mechanically.
4. Cards bearing individual plot volumes serve as a semi-permanent file to be used in subsequent regrouping of regional data.
5. Regardless of the nature of the report required, the data are constantly in unit form subject to whatever combinations may be necessary—a completely flexible system.

Other Forest Research Problems

The Branch of Research in Washington handles many forest problems by use of the punched-card method. Volume table data are transferred to cards and analyzed for various correlations between volume, diameter, form class, merchantable height, total height, etc. Yield table data punched on cards readily submit to the necessary analyses for yield studies. Forest nursery bed analysis for correlation between thrift and grade of stock, origin of seed, preparation of seed beds, method of planting, and various other factors may be successfully handled. Forest plantation information, thinning plot studies and a host of other problems have been similarly followed through.

The Forest Products Laboratory at Madison, Wisconsin, uses the punched-card method to a considerable extent in the compilation of the data from their mill scale, log scale, and selective logging studies with exceedingly satisfactory results. The Laboratory has perhaps found the method more useful than most other forest agencies because of the large quantities of data which they have to analyze. However, the advantage to the forest research worker, in general, of being able to separate and regroup his data at will, is an advantage not to be lightly disregarded in the face of the laborious manual work usually necessary to transcribe data satisfactorily for all necessary analyses and correlation.

PART VIII

Applications in Agricultural Research

CHAPTER V

Summarizing Contest Results

By
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Assistant Research Professor, Statistical Laboratory
Iowa State College

A High School Agricultural Congress and Conference of Students in Vocational Agriculture is held each spring at the Iowa State College at Ames, Iowa. Among the agricultural contests which provide competition for the vocational agriculture students from high schools of all sections of the state are the judging of farm crops and of livestock. A method for summarizing the results has been devised by the staff of the Statistical Laboratory.

It has been the custom, at this institution, to have the contestants in the livestock judging contest place ten classes of livestock and give reasons on five of them. In the farm crops contest, they place two classes in each of five kinds of grain, giving reasons on one class for each kind of grain, and identify two groups of ten crops each. Between fifty and seventy-five three-man teams compete in each of these two contests annually. The task of grading their work is great and when the tabulation by hand of results and determination of winners in the various classes are added to it an enormous load is placed on the shoulders of the members of the Animal Husbandry and Farm Crops departments. By use of punched cards and tabulating machines, the Statistical Laboratory has relieved these men of the most onerous part of their work, summarizing the results.

In this method, each man and team in the livestock contest is given a number at the time of registration and each man is given an envelope containing ten tabulating machine cards. Each envelope and each of the enclosed cards bears a team number and a contestant number which have been put on previously with numbering machines, Figs. 217 and 218. Each contestant puts his placings and writes his reasons directly on these cards which are then graded by men in charge of each kind of livestock judged. A few words of caution suffice to impress all with the necessity of not injuring the cards. The class of livestock and number such as, Percheron mares, No. 10, are written on the cards by the contestants. As soon as the cards are graded and the grades added, if both placing and reasons are required, they are taken to the Statistical Laboratory and punched and verified. They are then ready for sorting and tabulating which process will be explained for the farm crops contest.

Dual tabulating card used in summarizing Judging Contest Results

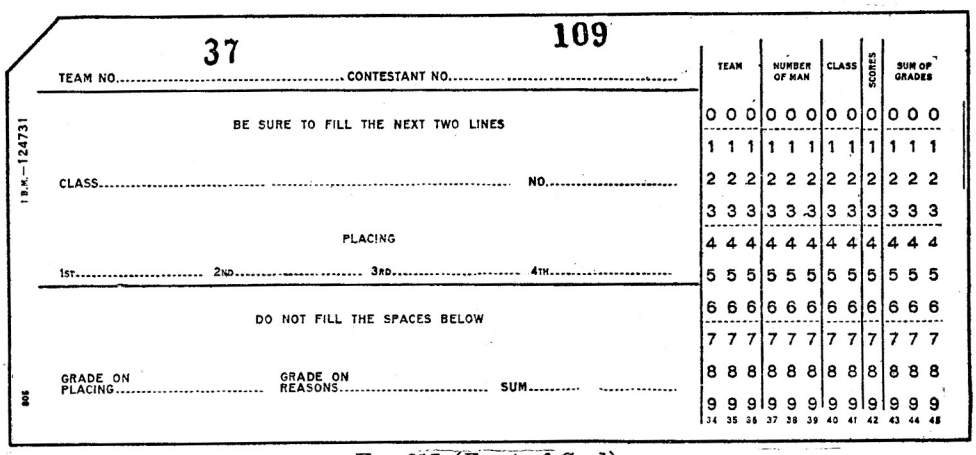


FIG. 217 (Front of Card)

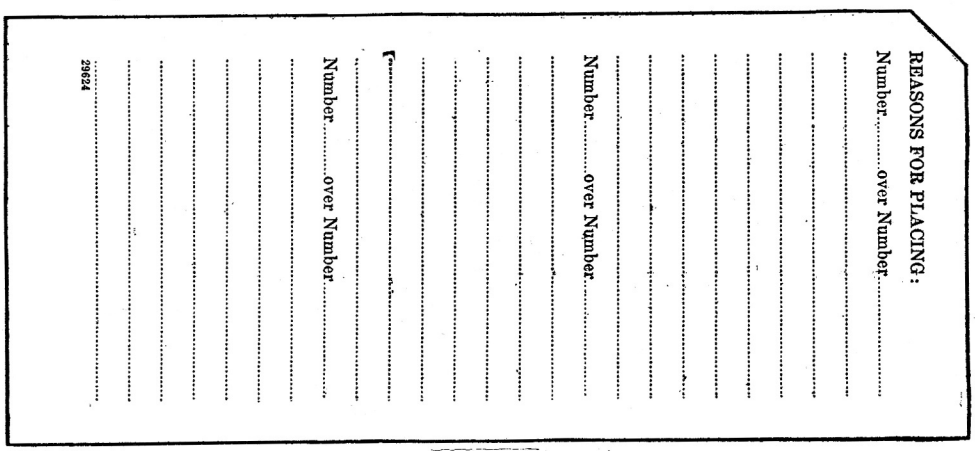
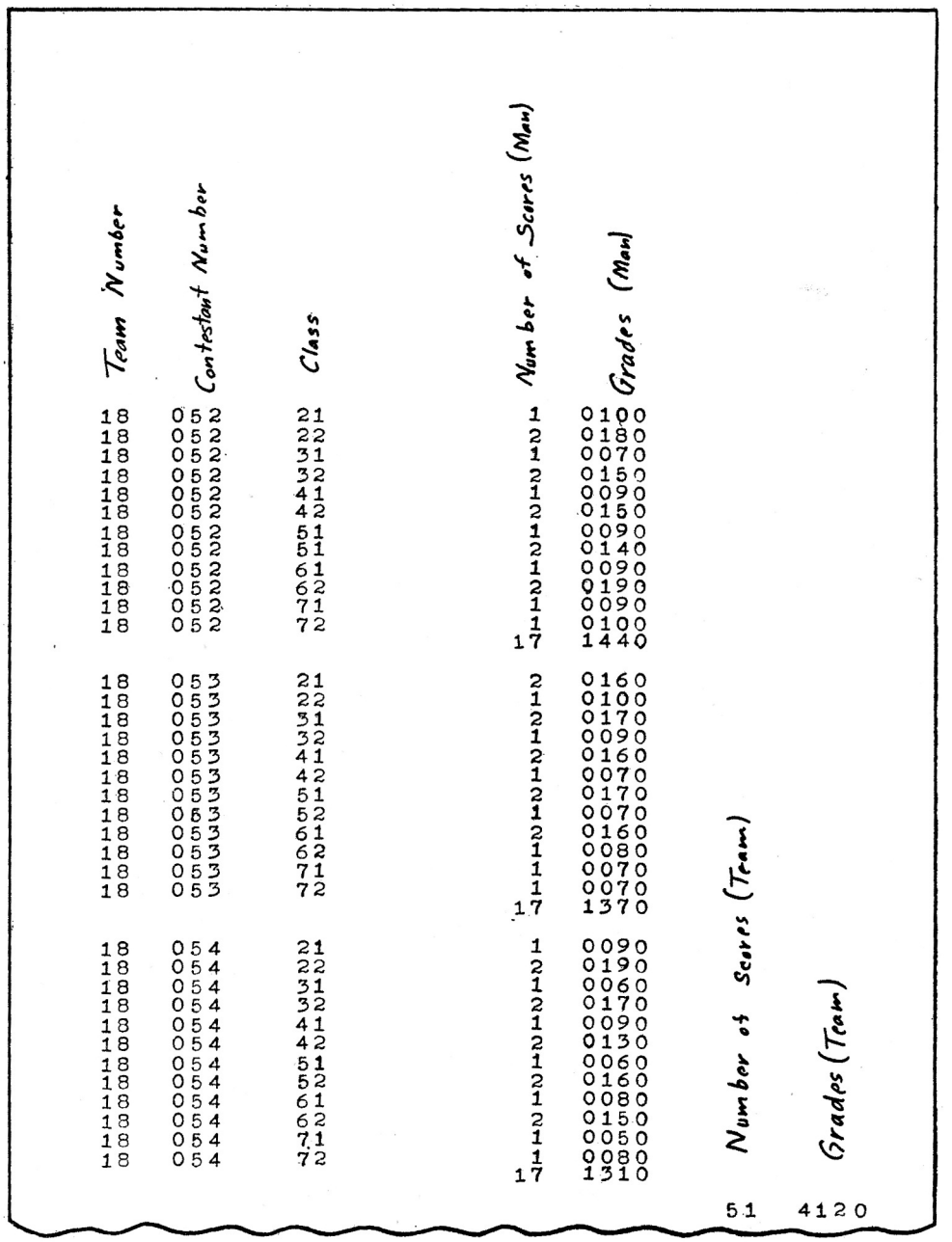


FIG. 218 (Back of Card)

The registration and numbering of the men and teams in the farm crops contest are done just as in the livestock contest but each envelope contains twelve cards. Ten of these cards are identical so that anyone may be used for any of the ten classes to be judged. The other two have a colored stripe along the top to indicate that they shall be used for the identification classes only. As with the livestock cards, the class and number must be written on the card by the contestant. As soon as the contestants have finished judging a class, the cards are collected, graded and sent to the Statistical Laboratory for punching and verifying. The headings at the right of the card are self explanatory except perhaps, "Scores." If only placing is given for a class a one is punched in the scores column, but if both placing and reasons are given a two is punched in that column.

After the cards are all punched they are sorted first on class then on number of man which automatically throws the members of a team together. They are



Team Number	Contestant Number	Class	Number of Scores (Man)	Grades (Man)
18	052	21	1	0100
18	052	22	2	0180
18	052	31	1	0070
18	052	32	2	0150
18	052	41	1	0090
18	052	42	2	0150
18	052	51	1	0090
18	052	51	2	0140
18	052	61	1	0090
18	052	62	2	0190
18	052	71	1	0090
18	052	72	1	0100
			17	1440
18	053	21	2	0160
18	053	22	1	0100
18	053	31	2	0170
18	053	32	1	0090
18	053	41	2	0160
18	053	42	1	0070
18	053	51	2	0170
18	053	52	1	0070
18	053	61	2	0160
18	053	62	1	0080
18	053	71	1	0070
18	053	72	1	0070
			17	1370
18	054	21	1	0090
18	054	22	2	0190
18	054	31	1	0060
18	054	32	2	0170
18	054	41	1	0090
18	054	42	2	0130
18	054	51	1	0060
18	054	52	2	0160
18	054	61	1	0080
18	054	62	2	0150
18	054	71	1	0050
18	054	72	1	0080
			17	1310
			Number of Scores (Team)	Grades (Team)
			51	4120

FIG. 219
A section of the tabulator tape showing standing of teams

then run through the printing tabulator. Fig. 219 is a copy of a portion of the tabulator tape for the 1934 contest. This run is made for four reasons: first, in order to determine whether or not each man turned in a card for each class with reasons on the proper ones; second, to determine whether the graders gave

each man credit for all he did; third, to check the accuracy of punching in all but the last three columns; and fourth, to provide a record which is cut up and distributed to the coaches so that they may know the performance of each team member in each class judged.

Since each team has three members, each member is supposed to have seventeen scores and for each kind of grain there must be one card bearing one score and another bearing two scores; any errors will appear on the tape and can be corrected. The member of the Farm Crops department who is in charge of their contest always assists in this checking and rectifies any errors the graders may have made. Sometimes a contestant will fail to give reasons on one class or find a class so hard to place that he will not hand in his card. In either case he will be short of the required seventeen scores. Thus, man number 50 of team number 17 in the contest this year failed to give reasons on one class. The record which the coach got credited this man with but sixteen scores so the coach called at the Statistical Laboratory to have a correction made, for the member of his team was certain that he had followed directions perfectly. The original cards were drawn from the file and given to the coach for inspection. He found that this boy had failed to give reasons on one class and went away fully satisfied that the results as printed on the tabulator tape were correct.

After all corrections have been made, the cards are again run through the printing tabulator and a summary run off. From this summary sheet a card is punched for each man giving the team number, contestant number, total grade for the contest, and, in the case of the third man on each team, the team score for the entire contest. The men are then ranked by sorting on the columns in which the man-scores have been punched and listing the score, man number and team number for each man. The teams are ranked by sorting on the columns in which team scores have been punched and listing the score and team number. In sorting on team scores, two cards for each team will go into the reject pocket. If the winners in different kinds of grains such as corn or wheat are desired, the necessary break downs are easily made. The results of the livestock contest are secured in essentially the same manner.

The printing on the face is the same for each use to which the cards are put in the judging contests and is done by the Tabulating Machine Division of the International Business Machines Corporation with an electrotype owned by Iowa State College but left in the possession of the company. This plate has been given the number IBM-124731 and Iowa State College will gladly give permission for any institution to have cards printed from it. The printing on the back of the cards differs (due to lack of space only one of the three forms is illustrated) and is done locally. It would not be necessary in a contest in which reasons were not given.

PART IX

Miscellaneous Research Applications

PART IX

Miscellaneous Research Applications

CHAPTER I

Anthropology

By
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Curator of Somatology, Peabody Museum of Harvard University

ALL anthropologists study man and his culture. The job of the physical anthropologist is to investigate the bodily characters of man. He is interested in human physique not so much from the point of view of the health of the individual subjects as from that of the hereditary or racial differences which separate one great group of men from another. It is his business to describe and analyze, to classify and compare, these anatomical features which may be the outward signs of mental and behavioristic differences. The physical features studied must also be related to certain sociological facts, such as, in a civilized state, occupation, education, marital status, and other fundamental circumstances of life which may influence man's physique or be influenced by it.

Under these conditions the physical anthropologist has to take a great many caliper measurements on each of his subjects, calculate many indices or relations of one dimension to another, and record in carefully graded categories a large number of qualitative attributes, such as hair color, which do not lend themselves to caliper measurements. In a routine anthropometric examination of a subject the Harvard Laboratory records about 125 facts, either metric or observational. But this is not all. Single subjects or small groups of subjects are of little or no use to the anthropologist who wants to find out the general characteristics of a race, a nation, or some large sociological group such as criminals. The anthropologist must measure hundreds and even thousands of individuals in order that he may be sure that his data properly represent the populations which he is investigating. This means an appalling mass of statistics which must be mathematically reduced, if any conclusions are to be drawn from them.

In the old days of hand tabulation and computation no sensible anthropologist was likely to study more than a few hundred subjects of any group, simply because he knew that the arithmetical labor of reducing his statistics would have to be counted in years. If he wished to find out the correlation between weight and height he would have to undertake the tedious drudgery of compiling a scattergram by reading off values of pairs of variables for long series of individuals. When this scattergram was finished and checked there would re-

main to be done a long series of arithmetical computations. Adding machines and calculating machines were, of course, a great help, but only after the statistical data had been arranged by hand and tabulated.

All of these laborious processes are eliminated or simplified by the use of the Hollerith sorting and tabulating apparatus.

In order to illustrate the use of these wonderful machines in the reduction of anthropometric data, I am going to describe the statistical problem which confronted me after I had carried out an anthropometric investigation of 17,000 criminals from ten states, and how this problem was solved by the use of Hollerith apparatus.

I suppose that everyone who reads this knows that the principle of Hollerith sorting and tabulating involves the punching of the raw data pertaining to each individual into a single record card, each fact being designated by one or more holes punched in the card in specific positions in numbered columns. Once the cards are punched they are fed into a machine which sorts and tabulates any desired combination of facts by brushes which make electrical contact through the various holes in the cards. The latest models of sorters handle about 400 cards per minute, while the three-bank printing sorter simultaneously counts on the column sorted and any other two columns.

For the criminal survey it was necessary to use the largest capacity Hollerith sorting card which contains 80 columns with places for 12 holes in each column. In most commercial uses of the Hollerith apparatus only a few facts are recorded on each individual card and it is possible to use a 45-column card or to utilize an entire column for each digit of numbers or amounts of money which have to be placed on record. In our criminal survey it was necessary to provide upon each card for a considerable number of values of each of about 125 variables. Such a mass of data for each individual not only requires the full capacity of the 80-column card, but necessitates the grouping and coding of all metric data and the use of double or triple punching in many columns which are subdivided in order to accommodate the recording of several different attributes.

The first step in the preparation of the raw individual record blanks is therefore the construction of a code whereby the data may be punched into Hollerith cards. Fig. 220 shows the arrangement of the card used for the criminal survey. It is divided up into fields according to the material to be recorded in each column and each subdivided column. Metric data are grouped in intervals varying according to the range and variability of each measurement. For example weight may be grouped in 10-pound intervals, so that a single column of 12 holes will accommodate the full range of weight variation in a very large series. Similarly, stature may be grouped in 3-centimeter intervals, while smaller measurements such as head length may be grouped in 3-millimeter intervals or less. The number of columns required for recording the metric variations of a single measurement or index depends upon the range of the variable and the fineness of the grouping interval used. The various observed attributes are graded in categories, each category requiring one hole in the punch card. Thus if eye color is recorded as dark brown, light brown, gray-brown, green-brown, blue-brown, blue, and gray, seven holes in one column

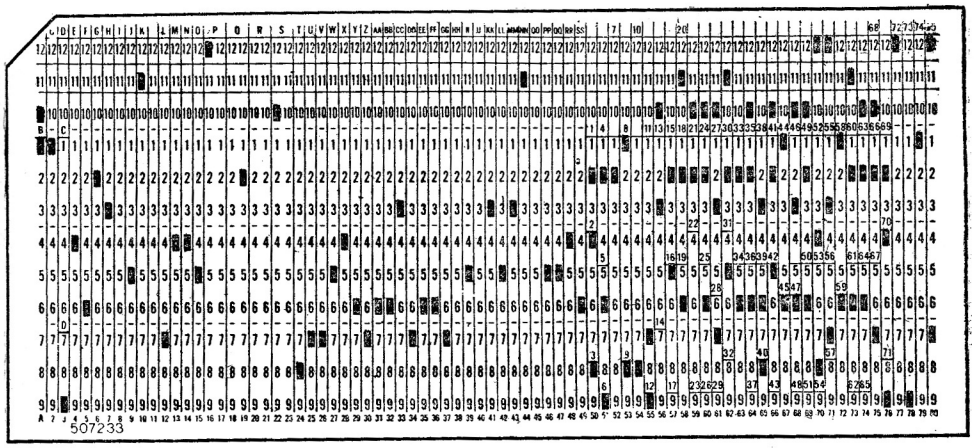
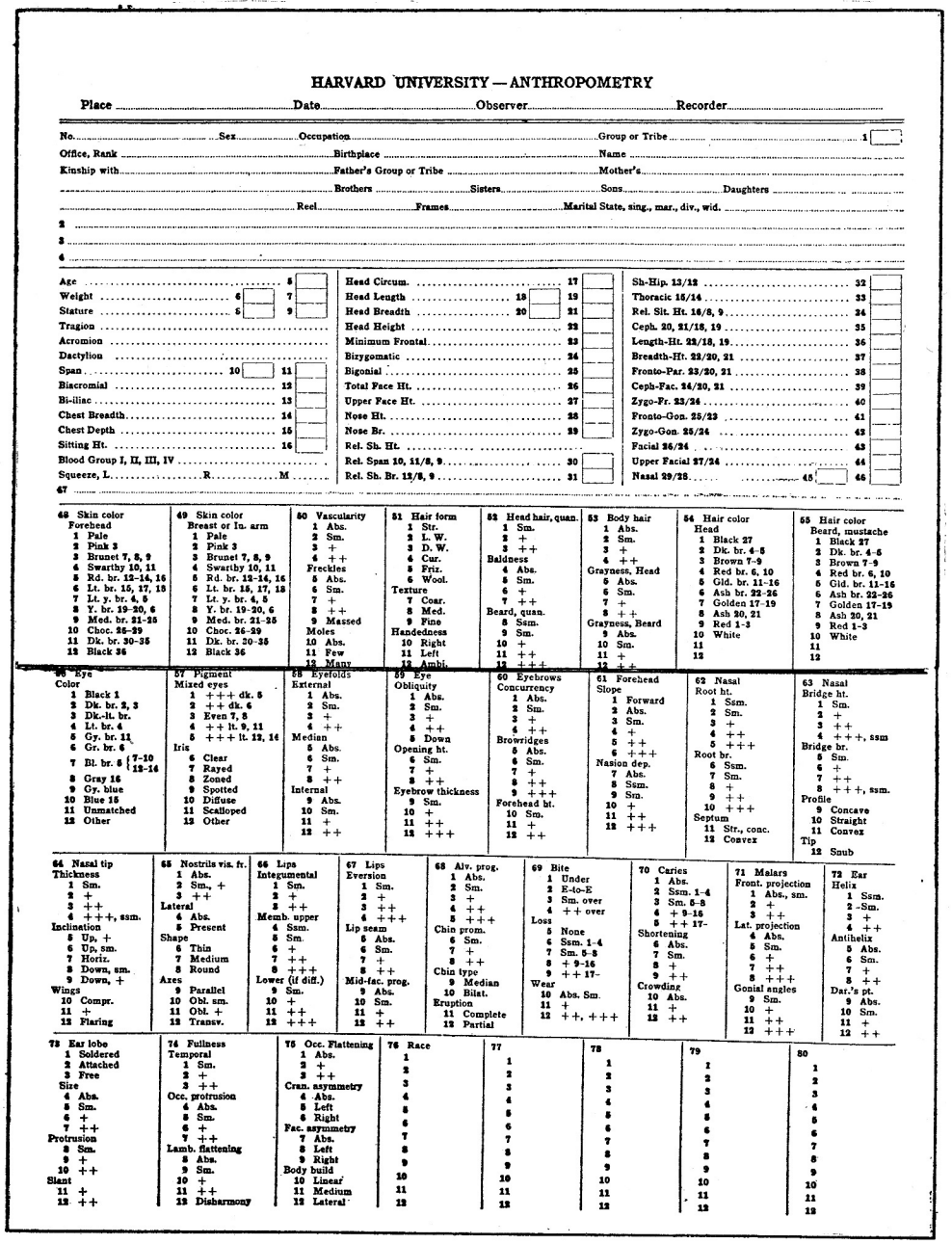


FIG. 220

are used for this information, but only one of these holes is punched in any single card. The first anthropometric codes thus devised were the result of much experimentation and a great deal of research in order to find the human ranges of metric features and the requisite number of categories for observational attributes. However, our statisticians are now able to handle any sort of specialized data with ease and dispatch, since we have perfected a standard universal anthropometric code which can be varied to suit the requirements of individual cases. This is shown on the record blank subsequently discussed. (See Fig. 221.)

Our field anthropometric studies of criminals were recorded on printed record blanks of a type similar to that used in all anthropological laboratories which do not employ mechanical sorting and tabulating apparatus. These blanks were not arranged in such a manner as to enable the punch machine operator to transfer the original record directly to the card. It was necessary to devise a precoding sheet from which the operator could work. This was an enlarged replica of the punch card with the number of each hole to be punched stamped in its proper position by transferring the field record into code. In the case of the criminal survey this precoding process consumed more than one year's time for a staff of six to eight clerks. We have now eliminated about nine-tenths of the labor of precoding by devising a field anthropometric record blank in which the data are arranged by columns and by numbers from one to twelve in each column exactly in the order in which they are to be punched into the Hollerith record card. With this new anthropometric blank which is shown in Fig. 221, all of the coding of observations is done by the field recorder and it requires only a few minutes of work in the statistical laboratory to add the codes for the sociological data and measurements and to prepare the record sheet for the punch machine operator. The intermediate precoding sheet has been completely eliminated.

Once the record cards are punched, the battle is won, since the sorting and counting machines will tabulate the data on the cards in any desired combination. In our criminal survey we desired first of all to record all physical and



HARVARD UNIVERSITY — ANTHROPOMETRY

Place ..... Date ..... Observer ..... Recorder .....

No. ..... Sex ..... Occupation ..... Group or Tribe 1

Office, Rank ..... Birthplace ..... Name .....

Kinship with ..... Father's Group or Tribe ..... Mother's .....

..... Brothers ..... Sisters ..... Sons ..... Daughters .....

..... Reel ..... Frames ..... Marital State, sing., mar., div., wid. .....

2 .....

3 .....

4 .....

Age 5
Weight 6 7
Stature 8 9
Tragion .....
Acromion .....
Dactylion .....
Span 10 11
Biacromial 12
Bi-iliac 13
Chest Breadth 14
Chest Depth 15
Sitting Ht. 16
Blood Group I, II, III, IV .....
Squeeze, L. ..... R. ..... M .....
67 .....

Head Circum. 17
Head Length 18 19
Head Breadth 20 21
Head Height 22
Minimum Frontal 23
Bizygomatic 24
Bigonial 25
Total Face Ht. 26
Upper Face Ht. 27
Nose Ht. 28
Nose Br. 29
Rel. Sh. Ht. .....
Rel. Span 10, 11/8, 9 30
Rel. Sh. Br. 12/8, 9 31

Sh-Hip. 13/12 32
Thoracic 15/14 33
Rel. Sit. Ht. 16/8, 9 34
Ceph. 20, 21/18, 19 35
Length-Ht. 22/18, 19 36
Breadth-Ht. 22/20, 21 37
Fronto-Par. 23/20, 21 38
Ceph-Fac. 24/20, 21 39
Zygo-Fr. 23/26 40
Fronto-Gon. 25/23 41
Zygo-Gon. 25/24 42
Facial 26/24 43
Upper Facial 27/24 44
Nasal 29/28 ..... 45 46

48 Skin color Forehead
1 Pale
2 Pink 3
3 Brunet 7, 8, 9
4 Swarthy 10, 11
5 Rd. br. 12–14, 16
6 Lt. br. 15, 17, 18
7 Lt. y. br. 4, 5
8 Y. br. 19–20, 6
9 Med. br. 21–25
10 Choc. 26–29
11 Dk. br. 30–35
12 Black 36

49 Skin color Breast or In. arm
1 Pale
2 Pink 3
3 Brunet 7, 8, 9
4 Swarthy 10, 11
5 Rd. br. 12–14, 16
6 Lt. br. 15, 17, 18
7 Lt. y. br. 4, 5
8 Y. br. 19–20, 6
9 Med. br. 21–25
10 Choc. 26–29
11 Dk. br. 30–35
12 Black 36

50 Vascularity
1 Abs.
2 Sm.
3 +
4 ++
Freckles
5 Abs.
6 Sm.
7 +
8 ++
9 Massed
Moles
10 Abs.
11 Few
12 Many

51 Hair form
1 Str.
2 L. W.
3 D. W.
4 Cur.
5 Friz.
6 Wool.
Texture
7 Coar.
8 Med.
9 Fine
Handedness
10 Right
11 Left
12 Ambi.

52 Head hair, quan.
1 Sm.
2 +
3 ++
Baldness
4 Abs.
5 Sm.
6 +
7 ++
Beard, quan.
8 Sam.
9 Sm.
10 +
11 ++
12 +++

53 Body hair
1 Abs.
2 Sm.
3 +
4 ++
Grayness, Head
5 Abs.
6 Sm.
7 +
8 ++
Grayness, Beard
9 Abs.
10 Sm.
11 +
12 ++

54 Hair color Head
1 Black 27
2 Dk. br. 4–5
3 Brown 7–9
4 Red br. 6, 10
5 Gld. br. 11–16
6 Ash br. 22–26
7 Golden 17–19
8 Ash 20, 21
9 Red 1–3
10 White
11
12

55 Hair color Beard, mustache
1 Black 27
2 Dk. br. 4–5
3 Brown 7–9
4 Red br. 6, 10
5 Gld. br. 11–16
6 Ash br. 22–26
7 Golden 17–19
8 Ash 20, 21
9 Red 1–3
10 White
11
12

56 Eye Color
1 Black 1
2 Dk. br. 2, 3
3 Dk.-lt. br.
4 Lt. br. 4
5 Gy. br. 11
6 Gr. br. 6
7 Bl. br. 8 {7–10 / 12–14}
8 Gray 16
9 Gy. blue
10 Blue 15
11 Unmatched
12 Other

57 Pigment Mixed eyes
1 +++ dk. 5
2 ++ dk. 6
3 Even 7, 8
4 ++ lt. 9, 11
5 +++ lt. 12, 14
Iris
6 Clear
7 Rayed
8 Zoned
9 Spotted
10 Diffuse
11 Scalloped
12 Other

58 Eyefolds External
1 Abs.
2 Sm.
3 +
4 ++
Median
5 Abs.
6 Sm.
7 +
8 ++
Internal
9 Abs.
10 Sm.
11 +
12 ++

59 Eye Obliquity
1 Abs.
2 Sm.
3 +
4 ++
5 Down
Opening ht.
6 Sm.
7 +
8 ++
Eyebrow thickness
9 Sm.
10 +
11 ++
12 +++

60 Eyebrows Concurrency
1 Abs.
2 Sm.
3 +
4 ++
Browridges
5 Abs.
6 Sm.
7 +
8 ++
9 +++
Forehead ht.
10 Sm.
11 +
12 ++

61 Forehead Slope
1 Forward
2 Abs.
3 Sm.
4 +
5 ++
6 +++
Nasion dep.
7 Abs.
8 Ssm.
9 Sm.
10 +
11 ++
12 +++

62 Nasal Root ht.
1 Ssm.
2 Sm.
3 +
4 ++
5 +++
Root br.
6 Ssm.
7 Sm.
8 +
9 ++
10 +++
Septum
11 Str., conc.
12 Convex

63 Nasal Bridge ht.
1 Sm.
2 +
3 ++
4 +++, ssm
Bridge br.
5 Sm.
6 +
7 ++
8 +++, ssm.
Profile
9 Concave
10 Straight
11 Convex
Tip
12 Snub

64 Nasal tip Thickness
1 Sm.
2 +
3 ++
4 +++, ssm.
Inclination
5 Up, +
6 Up, sm.
7 Horiz.
8 Down, sm.
9 Down, +
Wings
10 Compr.
11 +
12 Flaring

65 Nostrils vis. fr.
1 Abs.
2 Sm., +
3 ++
Lateral
4 Abs.
5 Present
Shape
6 Thin
7 Medium
8 Round
Axes
9 Parallel
10 Obl. sm.
11 Obl. +
12 Transv.

66 Lips Integumental
1 Sm.
2 +
3 ++
Memb. upper
4 Ssm.
5 Sm.
6 +
7 ++
8 +++
Lower (if dif.)
9 Sm.
10 +
11 ++
12 +++

67 Lips Eversion
1 Sm.
2 +
3 ++
4 +++
Lip seam
5 Abs.
6 Sm.
7 +
8 ++
Mid-fac. prog.
9 Abs.
10 Sm.
11 +
12 ++

68 Alv. prog.
1 Abs.
2 Sm.
3 +
4 ++
5 +++
Chin prom.
6 Sm.
7 +
8 ++
Chin type
9 Median
10 Bilat.
Eruption
11 Complete
12 Partial

69 Bite
1 Under
2 E-to-E
3 Sm. over
4 ++ over
Loss
5 None
6 Ssm. 1–4
7 Sm. 5–8
8 + 9–16
9 ++ 17–
Wear
10 Abs. Sm.
11 +
12 ++, +++

70 Caries
1 Abs.
2 Ssm. 1–4
3 Sm. 5–8
4 + 9–16
5 ++ 17–
Shortening
6 Abs.
7 Sm.
8 +
9 ++
Crowding
10 Abs.
11 +
12 ++

71 Malars Front. projection
1 Abs., sm.
2 +
3 ++
Lat. projection
4 Abs.
5 Sm.
6 +
7 ++
8 +++
Gonial angles
9 Sm.
10 +
11 ++
12 +++

72 Ear Helix
1 Ssm.
2 Sm.
3 +
4 ++
Antihelix
5 Abs.
6 Sm.
7 +
8 ++
Dar.'s pt.
9 Abs.
10 Sm.
11 +
12 ++

73 Ear lobe
1 Soldered
2 Attached
3 Free
Size
4 Abs.
5 Sm.
6 +
7 ++
Protrusion
8 Sm.
9 +
10 ++
Slant
11 +
12 ++

74 Fullness Temporal
1 Sm.
2 +
3 ++
Occ. protrusion
4 Abs.
5 Sm.
6 +
7 ++
Lamb. flattening
8 Abs.
9 Sm.
10 +
11 ++
12 Disharmony

75 Occ. Flattening
1 Abs.
2 +
3 ++
Cran. asymmetry
4 Abs.
5 Left
6 Right
Fac. asymmetry
7 Abs.
8 Left
9 Right
Body build
10 Linear
11 Medium
12 Lateral

76 Race
1
2
3
4
5
6
7
8
9
10
11
12

77
1
2
3
4
5
6
7
8
9
10
11
12

78
1
2
3
4
5
6
7
8
9
10
11
12

79
1
2
3
4
5
6
7
8
9
10
11
12

80
1
2
3
4
5
6
7
8
9
10
11
12

FIG. 221

Pre-coded Anthropometric Record Blank

(Double line in center indicates division between Front and Back of Blank)

sociological characteristics of each criminal group distinguished as to race, nativity, nationality of parents, and nature of offense. This involved a sorting for race and subsequent sortings of each racial group until the desired subdivision was obtained. Then each offense group so distinguished was tabulated

for all of the remaining data on the record card. This process yielded the seriations required for calculating means and other constants of metric data as well as frequencies and percentages of morphological and sociological observations.

By the use of the sorter and printing card counter, correlation tables or contingency tables can be built up in one very rapid operation so that the relationships between variables and attributes can be determined with practically no expenditure of labor. By the use of the Hollerith tabulator correlation processes can be carried out almost in their entirety. However, we do not employ the tabulator regularly in the Harvard Anthropometric Laboratory, because we use codes instead of punching metric data directly into the record cards. If one employs the latter method (which necessitates the use of a whole column for each digit of a numerical value) the tabulator will add the total of the columns, carrying the results over from one column to the next. Any statistical laboratory which specializes in large correlations would naturally employ this piece of apparatus, as would also a laboratory dealing with monetary records.

In the course of elaborating our criminal data, one process was performed by the Hollerith sorter which in its complexity is probably unique in anthropometric research. In our series of native white criminals of native parentage there is included a group of 414 robbers. These robbers display as a group a number of statistically significant excesses and deficiencies of certain categories of morphological features—nine in number. These include excess of no asymmetry, of wavy and curly hair, of external eye folds, of light brown eyes, diffused irises, etcetera. It was desired to ascertain how many individual robbers manifested each one of every mathematically possible combination of these nine morphological peculiarities. Since there are 512 possible combinations of the presence and absence of these characters, the sorting task involved was stupendous and consumed several weeks of the entire working time of the sorter. The object of this work was to determine whether it would be possible to select robbers from criminals in general by individual combinations of physical peculiarities. In other words the solution of this problem was the final answer to the long debated question as to whether there is a criminal type which is exclusive to robbers. The outcome of the research was a conclusive demonstration that, by taking a sufficient number of peculiarities of the robber group in combination and selecting all of the individuals who possessed that combination, it was possible to pick out a type which was 100 per cent robber. At the same time it was demonstrated that only one robber out of 414 showed this complete and exclusive type combination. It was therefore apparent that morphological type combinations were of no practical use in determining the offenses of criminals, so far as our particular data were concerned.

I have expatiated upon this experiment because it illustrates the fact that the use of Hollerith apparatus enables the statistician to carry anthropometric analysis to a point of fineness which is comparable only with the identification of individuals by microscopic finger print variations. The sorting task accom-

plished in the case of these robbers would have consumed the entire time of a large clerical force for some months, if done by hand, and would probably have sent a considerable number of the workers into sanitaria for treatment of mental cases.

Actually the Hollerith apparatus has transformed the biometric study of man from an inexact melange of unrelated averages of metric characters and general statements about the group occurrence of attributes, to a precise mathematical tabulation of frequency of individual combinations of metric and morphological features. So far as the data are good it has made of human biometry an exact science. Now for the first time the anthropologist can tackle the study of human attributes on a sufficiently large scale to yield results which he knows to be correct because they are based upon adequate numerical samples exhaustively analyzed.

It is quite obvious that the utility of mechanical tabulating is not restricted to physical anthropology, but is equally applicable to all biological and sociological phenomena which are the resultants of different combinations of multiple variables and attributes.

PART IX

Miscellaneous Research Applications

CHAPTER II

Astronomy

By
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Assistant Professor of Astronomy, Columbia University

THE numerical calculation involved in astronomical research has always been a problem of the greatest importance. Much of this computation can be performed by people of little training, but this does not relieve the astronomer of the task of securing funds for the purpose or of the necessity of planning and checking the work. The result is that many problems are passed over for lack of funds; or that the energy of men of scientific ability is spent on computation.

There have been three major advances in computing methods brought about respectively by the introduction of logarithms, of manually operated computing machines, and of automatic tabulators using punched cards. The first table of logarithms was published by John Napier in 1614, and for nearly three centuries all extensive calculations were performed by this method. The present generation has seen the logarithm replaced by hand and electric computing machines. These are all similar in that the simple operations of arithmetic are performed more or less automatically upon numbers which are put into the machine by hand. For the automatic tabulators the initial numbers are punched on cards and checked. From then on they receive no personal attention, as they are automatically transferred through flexible wiring to the proper place in the machine for the various operations.

The complete line of equipment using the punched card system is too extensive to describe here except to say that there are standard machines for practically all purposes. They have been developed for commercial uses but with slight modification become ideal for scientific work. The main question in any case is not "can the problem be solved by these machines", but rather "have I enough operations of this type or that to justify such powerful equipment." It might be mentioned also that with standard parts special machines for almost any imaginable purpose could be constructed, but except in very rare cases the expense involved makes the standard machines preferable.

In view of the wide variety of machines and their possible uses it seems most desirable to describe particular machines and the particular problems to which they have been applied. I shall, therefore, describe the work done with the earlier machines at the British Nautical Almanac Office, and that now being done with the more modern equipment at Columbia University.

First Scientific Use of Tabulator

Dr. Comrie has described the use of the key punch, verifier, sorter, and printing tabulator in connection with two problems: (1) the construction of tables by interpolation and (2) the summation of periodic series.* In the construction of tables the first or higher differences of the function to be tabulated are found and punched on cards. The tabulator adds these differences and prints the argument, the difference, and the function. In the computation of an ephemeris of the moon it is necessary to add for each date a great many periodic terms. The contributions of each of these terms at equal intervals of time during one revolution are punched on cards. For a given date the cards are collected from the tops of the piles and added on the tabulator. At the end of a period the cards are sorted and the process repeated.

Work Now Being Done at Columbia

The equipment at Columbia is shared with the Statistical Bureau and is, therefore, more complete than would be necessary for this department alone. The essential units for scientific work are a key punch, a verifier, a sorter, a cross footing multiplying punch, and a direct subtraction tabulator with summary card punch. The automatic reproducer, the gang punch, and the interpreter are also used. The multiplier is standard except for two features: (a) The multiplier and multiplicand may be positive or negative and the proper sign of the product will be indicated. (b) The machine performs with one operation the problem of direct interpolation in tables. The summary punch is also standard except for the fact that provision is made for automatically changing the algebraic signs of numbers punched on cards.

The immediate program of research consists principally of three problems:

(1) Stellar statistics.
(2) Planetary motions.
(3) The construction of star catalogues.

In the solution of these problems there are many types of work which are important in other kinds of research. The second involves the numerical integration of differential equations, the formation of normal equations for solution by the method of least squares, the solution of linear algebraic equations, and the differencing of tables. The third involves direct interpolation in tables, the summation of power series, and the construction of card catalogues.

Stellar Statistics

The problem of stellar statistics is a natural place for using tabulating equipment. For this purpose we need only the punch, verifier, sorter and ordinary tabulator. The pertinent information about each star to be considered is punched on a card. Numerical information is punched directly, or as a complement when negative. Literal information such as the spectral

* On the Construction of Tables by Interpolation. L. J. Comrie. Monthly Notices, R.A.S., Apr. 1928. The application of the Hollerith Tabulating Machine to Brown's Tables of the Moon. L. J. Comrie. Monthly Notices, R.A.S., May, 1932.

type is coded into numbers. The cards can be readily sorted into groups according to any classification on the cards, and for each group the different quantities may be added on the tabulator. The principal work involved is the preparation of the card catalogue, for the additions may be performed on a dozen quantities at once and at the rate of nearly ten thousand per hour. To date we have punched on cards the information from Kohlschutter's catalogue of about 5,000 stars, and the Yale Zone Catalogue of about 10,000 stars from declination $+25°$ to $+30°$. The cards from the first catalogue contain (1) catalogue number, (2) right ascension, (3) declination, (4) parallax, (5) spectral type, (6) radial velocity; (7) magnitude, (8) three space velocity components, (9) total space velocity, (10) derivatives of the velocity components with respect to the parallax. For the second catalogue the parallaxes and radial velocities are not given, and the space velocity components are replaced by the angular velocity components.

As an example of the use of the first catalogue consider one run which was made in about three hours. It was desired to separate the stars into 96 groups according to galactic longitude and latitude. These coordinates were not on the cards, but from a scheme giving the limits of right ascension and declination corresponding to the required limits of galactic latitude and longitude, it was easy to sort into the required regions by the given coordinates. For each group the tabulator added 10 quantities. Each of the five counters were split so as to give ten totals in one run. Division of the totals for each kind of information by the number of stars in the group gave the average value for the group of the three space velocity components, the parallax, the spectral type, the magnitude, the total velocity and the three derivatives mentioned above. To do this counting by hand would require about two months of tedious labor.

Planetary Motions

The problems of celestial mechanics have occupied the attention of men of mathematical ability for centuries. Some of this work has been for the proving of general theories, but a great amount has been simply the problem of seeing to what extent the motions computed on the assumption of Newton's laws of motion and gravitation agreed with the observed facts. There have existed simple numerical methods for the purpose, but the labour of applying them was so great that they have been used only for small problems.

The method now being used at Columbia on the planet Vesta is similar to that used by Cowell and Crommelin on Halley's comet.* The complete process of numerical integration is performed and checked on the machines. The advantages of the machine method in addition to those of speed and accuracy are that all portions of the computation are recorded on cards so that they may be used for other purposes. For instance, a small change may be made in the elements and the new values of the coordinates obtained with almost no additional work.

* Investigation of the Motion of Halley's Comet from 1759 to 1910. P. H. Cowell, A. C. D. Crommelin. (Forming an Appendix to the Volume of Greenwich Observations for the year 1909.) Neill & Co. Limited, Bellevue, England, 1910.

In Cowell's Method a table of equatorial rectangular coordinates x, y, z, is developed from the second differences. These second differences, being the accelerations due to the sun and planets at that instant, are computed from Newton's Law. The computation of the accelerations consists essentially of deriving quantities of the form

$$X = \frac{k^2(x_p - x)}{r^3}$$

$$Y = \frac{k^2(y_p - y)}{r^3}$$

$$Z = \frac{k^2(z_p - z)}{r^3}$$

where $r^2 = (x_p - x)^2 + (y_p - y)^2 + (z_p - z)^2$, x_p, y_p, z_p being the coordinates of the disturbing planets. The subtractions are made three at a time with the subtraction tabulator and the multiplications and cross additions on the cross footing multiplier. The quantity $\frac{1}{r^3}$ comes from r^2 with the help of a card catalogue of quantities to the minus three halves power, being interpolated automatically on the multiplier. The coordinates of the major planets x_p, y_p, z_p are punched once for all on cards and serve for any orbits computed by this method. The accelerations are added on the tabulator and then used for the double summation. The results of the second summation differ from the coordinates by quantities which are small multiples of the successive differences of the acceleration. These differences are derived by means of the tabulator and the attachment for reversing the algebraic signs of numbers. The calculation may be performed with final accuracy at each stage, or by the method of successive approximations. With the latter method the machines are used to their full efficiency but the calculations may have to be repeated several times. With the former the first results are final, but all the different operations must be performed for a given epoch before proceeding to the next. This latter method is facilitated by an auxiliary switch box for automatically changing the wiring.

The coordinates obtained by the above process are those of a body moving according to Newton's Law and which had the initial coordinates and velocities. We must now compare those positions with the observations. The observations consist of the direction in which the object was seen from the earth. These observed directions are compared with similar directions computed from our table of x, y, z. Most of this calculation is also done on the tabulators, though we shall not describe it here. After the comparison we wish to know to what extent the discrepancies can be accounted for by the fact that we did not assume the best values for the starting coordinates and velocities, and to what extent they are due to other causes. The first step is to make a least-squares solution for corrections to the six elements. In the case of a well observed planet there are several thousand observations. The normal equations whose coefficients are of the form $\Sigma\, a_i\, a_j$ may be formed in two ways: (1) by making the necessary multiplication on the multiplier and adding on the tabulator, or (2) by using a method similar to the Mendenhall-Warren-

*** The Mendenhall-Warren-Hollerith Correlation Method. Columbia University Statistical Bureau. Document No. 1. Also The Use of Machine Factoring in Multiple Correlation, A. E. Brandt, Journal of the American Statistical Association, September, 1928.

Hollerith method of computing correlation coefficients.* The normal equations may be solved by elimination on the multiplier as described below. After the solution the effects of small changes in the initial conditions are easily applied to x, y, z. The solution by this method leaves the results on the cards where they are very conveniently arranged for statistical discussion.

The construction of the card catalogue of coordinates of the major planets is an extensive piece of work but one which need be done only once. A duplicate set of these cards could very easily be made for another observatory. The methods of checking such a catalogue for accidental errors is of interest. The motion of a given planet is to a first approximation periodic, so that after a given time the coordinates will be very nearly repeated. Hence we can find an interval in which an integral number of periods will be approximately equal to an integral number times the interval of tabulation. The failure of exactness will be small enough that first order interpolation will do. For this purpose we construct a catalogue of first differences of the coordinates extending over one period. This we multiply by the closing error in the period and add to the old values of the coordinates. The results will agree to the accuracy with which the motion is periodic. The residual error which is due only to perturbations will be small and will vary so uniformly that inspection will detect any error larger than one or two in the last place. Where only approximate values of the coordinates are necessary the perturbations may be neglected and the above method used for the original computation.

The method described above for the solution of the problem of planetary motions may be applied to almost any problem of numerical integration. In the case of planetary motions there are three dependent variables which are built up from second derivatives. If there were only one dependent variable, it might be desirable to carry the solutions for several values of a parameter.

A set of n linear equations in n unknowns may be conveniently solved on the tabulator and multiplier by the ordinary method of Gauss. There will be $nx(n+1)$ given numbers including the constant terms. Each of these may be punched on a card together with numbers indicating the equation and the position in the equation from which it came. When many sets of equations are solved at the same time, the cards should carry the number of the set of equations. The different operations on a given set may be indicated by color of cards or by a number. The cards for the first equation are passed through the multipliers with the negative reciprocal of the first coefficient as fixed multiplier. The results will be in turn multiplied by each of the first coefficients of the other equations. These cards are paired with the original cards for the various coefficients by means of the sorter and then added on the tabulator. The resulting summary cards form a set of n—1 linear equations in n—1 unknowns and the process may be repeated. The only hand computation is that of finding a reciprocal, and this is immediately checked by the multiplier. Where many unknowns are involved it may be desirable to carry cards with the customary check sums. In the case of normal equations for the method of least squares the solutions with 1,0,0,...; 0,1,0,...; etc. for the determination of the weights would be included. When the last unknown

is found, the process of substitution is performed by operations similar to the preceding ones, as is the process of substituting in the original equations. Where the order of elimination is important, the sorter may be used to put a set of coefficients in order. The advantages of this method of solution become very great when there are many similar sets of equations, as most of the time is required for the changing of the wiring rather than for the actual operation of the machines.

Star Catalogues

The construction of a catalogue of photographic star positions is an example of work where many simple calculations must be made a huge number of times. The most expensive part of the calculation consists of the conversion for each star of the spherical coordinates on the sky to the rectangular coordinates on the photographic plate. Some of the other calculations are the application of precession, the determination of the plate constants from the comparison stars by the method of least squares, and the application of the terms of various orders in the coordinates depending upon these plate constants.

We will describe the method of converting spherical into rectangular coordinates as this illustrates several types of machine computation. The well known formulae are:

$$X = \frac{\tan \Delta \alpha}{\frac{\tan \delta'}{\cos \Delta \alpha} \sin \delta + \cos \delta} \qquad Y = \frac{\cos \delta \frac{\tan \delta'}{\cos \Delta \alpha} - \sin \delta}{\sin \delta \frac{\tan \delta'}{\cos \Delta \alpha} + \cos \delta}$$

X, Y are the rectangular coordinates on the plate.

δ' is the declination of the star.

δ is the declination of the center of the plate.

$\Delta\alpha$ is the difference in right ascension between the star and the center of the plate.

The average number of stars on a plate is about 1000, and the plates overlap so that each star appears on two plates. The first operation with the summary punch subtracts the right ascensions of the two plate centers from that of the star and converts the $\Delta\ \alpha$'s from time to arc; and gives the tangent of the declination for the nearest tabular value of the argument, together with the first difference. The resulting card contains the star number, the right ascension of the star in hours, minutes, seconds and decimals, the two $\Delta\ \alpha$'s in seconds of arc, the declination in degrees, minutes, seconds, and decimals, the tangent of the even number of degrees, minutes and tens of seconds, and the difference in the tangent for 10″. The printed record (Fig. 222) contains all these numbers except the first three digits of the star number and the hours of right ascension. These numbers change very infrequently and are applied to the card by means of a master card. This device makes it possible to summary punch more digits than the capacity of the tabulator counters. The multiplier with the special device for performing operations of the type $A \pm (B \times C)$ now interpolates the tangents at one operation. A card catalogue

STAR NUMBER	α	δ′	tan δ′	Δ α_1	tan δ′(con'd)	Δ α_2	dif. tan δ′
9432043771		375021876		25155969		1996845502	
9452121421		3091762336		81630785		1940370512	
9462146571		3090502336		119355274		1902645511	
9472153141		3150082354		129210687		1892790512	
9482157831		1503422096		136245700		1885755506	
9492245321		2184602182		207480384		1814520508	
9502329351		3494882461		273525377		1748475514	
9512330921		570291934		275880748		1746120503	
9522353701		3212432374		310050140		1711950512	
9532404701		1380252058		326550769		1695450505	
9542413461		2280912210		339690844		1682310508	
9552423581		3170702360		354870829		1667130511	
9562422571		2062122144		353355828		1668645508	
9572434451		3593852491		371175735		1650825515	
9582451331		3112122343		396495433		1625505511	
9602503451		1562262114		414675420		1607325507	
9612507521		4134432535		420780548		1601220516	
9622510701		233401833		425550840		1596450501	
9632554901		2162402175		491850275		1530150507	
9652613771		2001092126		520155072		1501845507	
9662616881		4022842500		524820491		1497180515	
9672628141		4130942533		541710484		1480290516	
9682624541		441951896		536310048		1485690502	
9702635491		3294892399		552735762		1469265513	
9712701521		1062161962		591780929		1430220503	
9722732451		1350242049		638175674		1383825505	
9732735231		190781820		642345313		1379655501	
9742739181		535701925		648270194		1373730502	
9752743781		32821773		655170269		1366830500	
9762753841		3183572365		670260436		1351740512	

FIG. 222

Star catalogue printed by tabulating machine

giving for $\Delta\alpha$, $\tan \Delta\alpha$ and $\frac{1}{\cos \Delta\alpha}$ together with their differences is used with the multiplier to give the exact values of $\tan \Delta\alpha$ and $\frac{1}{\cos \Delta\alpha}$ The product $\frac{\tan \delta}{\cos \Delta\alpha}$ is formed and the numerator and denominator of the expression for Y computed. The latter is performed with one operation. A card catalogue then gives the reciprocal of the denominator multiplied by the scale factor of the camera, together with its difference. One interpolation and two multiplications give X, Y.

In most computations with tabulators extensive use is made of card catalogues. With the help of the summary card punch such catalogues are not difficult to make. Frequently the catalogue may be computed ab initio on the tabulators and punched directly. In the case of published tables such as sines and cosines of angles we need punch by hand only the first differences, and with the tabulator and summary punch derive the argument, the function and the difference.

Before the newer machines were developed the conversion of spherical to rectangular coordinates was performed on the standard tabulator by means of power series. The computation was then of this form:

$X = \Delta\alpha \ [\ a + b\ \Delta\delta + c\Delta\alpha^2 + d\Delta\alpha^2\ \Delta\delta + e\Delta\delta^3 + f\Delta\alpha^2\Delta\delta^2 + g\Delta\alpha^4]$

$Y = b'\Delta\delta + c'\Delta\alpha^2 + d'\Delta\alpha^2\Delta\delta + e'\Delta\delta^3 + g\Delta\alpha^4 + f\Delta\alpha^2\Delta\delta^2 + h\Delta\delta^5 + i\Delta\alpha^4\Delta\delta + i\Delta\alpha^2\Delta\delta^3$

$\Delta\alpha, \Delta\delta$ were derived as in the newer method. A card catalogue containing powers from the first to the fifth of numbers from 1 to 2,000, and additional catalogues for interpolation in the second and third powers were used. The final power series were evaluated by drawing cards for each term from catalogues containing the argument times the constant coefficients a, a', b, b'-------. For the product terms it was necessary to resort to double entry tables for the smaller terms and to the following artifice for the large ones. For the $\Delta\alpha^2\Delta\delta$ term a five figure multiplication was necessary. Hence five sets of cards were used each containing products 1x1, 1x2, -----1x9, 2x1------2x9, 9x1 ------9x9. By using the proper combinations of these cards the complete multiplication was effected. Of course, the cards for a particular term carried the contributions to both X and Y while reversal of the card gave complements for the negative terms.

PART IX

Miscellaneous Research Applications

CHAPTER III

Economics

By
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THE interests of men are, in the main, social in character. Life, particularly in modern society, is characterized by an important series of interrelationships. Individual independence and isolation are rarely found. On the contrary, the social structure appears to be growing in complexity and the bonds of mutual dependence are becoming closer.

Attempts to analyze, understand and to regulate intelligently these social relationships are, therefore, tending to assume an increasing degree of importance. Less and less is it possible for responsible leadership to depend upon personal knowledge and observation as a basis for direction and control. More and more must it rely upon the interpretation of facts and figures, and upon the findings of specialized investigation.

Statistical research has, therefore, come to occupy a prominent position in the field of economics and related social studies. The practical policies of business or of governmental bodies, as well as the academic projects leading to the formulation of basic principles and theories, have become increasingly dependent upon an adequate collection and presentation of statistical data. Within the last generation, the advance of specialization, both occupational and territorial, and the more rapid tempo of social change have added to the complexity of economic life. This has emphasized more than ever the necessity for the reliance upon statistics for the proper understanding and regulation of economic phenomena.

Much as the compilation of certain statistical data may be desired, however, the expense and the time involved in sorting and tabulating the information, have frequently deterred individuals from going ahead with a given project. Especially is this true of studies which would require detailed classification and cross classifications of large assortments of items. The arduous work of hand-sorting schedules into main groups and sub-groups, and of counting and tabulating each total, rapidly raises the costs of a statistical study to unwarranted levels, and usually results in a reduction in the scope of the project to less ambitious proportions.

To a large extent, the introduction of mechanical methods of counting, sorting and tabulating numerical facts has eliminated these difficulties. Electric machinery, capable of performing routine operations at the rate of several hundred per minute, has increased the speed and lowered the expense of preparing statistical tabulations. This has resulted in a broadening of the field of statistical research and analysis and has stimulated the projection of studies which, without the use of such equipment, would no doubt have been considered impossible or impractical of accomplishment.

The use of machinery of this type involves the transfer of data from original schedules to standardized punched cards. This requires the codification of each item to be tabulated, so that the holes punched in certain sections of the cards may represent specific statistical facts. The classification, grouping and correlation of individual code items on each card may then be made in any variety of ways, and the conclusions which may be drawn from the resulting tabulations will, of course, be based upon the meanings which lie behind the individual code items.

Obviously, the speed and the reduction of effort and expense in resorting to mechanical methods of tabulation are made possible because of the elimination of the human factor in most of the routine tasks of counting and sorting. If, however, the work of transferring the original data to the tabulation cards is complicated and time-consuming in character, such losses may more than counterbalance the gains derived. It is important, therefore, when tabulating equipment is to be employed, to recognize this fact at the very inception of a statistical study. Plans should be made for co-ordinating the collection and editing processes with the requirements for tabulating so that a minimum of difficulty is involved in the transition from one operation to another. Otherwise many of the advantages of the machine technique will disappear.

An interesting application of the use of electrical tabulating machines may be cited in describing the methods employed in a statistical study of the operation of several state sales taxes. This study was conducted in 1933 under the auspices of Columbia University.*

The purpose of the project was to develop an inductive examination of the effects which sales tax legislation had produced in a number of important sections of the country. In order to accomplish this it was decided to make a canvass of business establishments and, by means of a questionnaire, to record the reactions and policies of the individuals interviewed, with respect to the tax.

Accordingly, one of the first tasks which were set during the initial stages of planning was to prepare a rough draft of a questionnaire. After a certain amount of discussion and critical examination of the problems involved, a preliminary form was drawn up. (See sample page, Fig. 223.) This questionnaire contained queries requiring approximately thirty short answers.

Before the work could progress much further, however, it became necessary to make at least a tentative estimate of the scope of the study. This concerned

* The results of this study were recently published in "The Sales Tax in the American States," Robert Murray Haig and Carl Shoup—Columbia Univ. Press, 1934.

the following questions:

(1) the number of states to be included in the survey
(2) the urban and rural areas to be selected in each state
(3) the industries or lines of business to be studied
(4) the choice of adequate samples.

It soon became evident, after a brief consideration of the factors involved, that this was a research project which would require the use of mechanical tabulating facilities. This conclusion was reached after a few hasty computations of minimum sorting and counting operations which would be needed. To illustrate, suppose that the study were limited to one state—say New York. Suppose further, that New York City were chosen as the single, most representative and most accessible study area, and that twenty-five major lines of business were arbitrarily selected for the sampling process. (In order to obtain an adequate sample it was decided that at least ten per cent. of the establishments in these twenty-five fields would have to be interviewed. This, it was judged, would include more than 5,000 firms.) If each concern answered all questions, some 150,000 total replies would then be received. Naturally, to be of value, these replies would have to be classified into such categories as "size of business," and "nature of business." Further sub-classifications into "dealers exempt from the tax," "those not exempt," "those shifting the tax," and "those assuming the tax burden" would undoubtedly be required. This would necessitate sorting, re-sorting and counting—which would quickly run into several million unit operations.

The vastness of this single project for New York City, *if attempted by hand tabulation methods,* might have eliminated all possibility of extending the study to other cities and states, and to rural areas. Both the amount of funds and the time available were definitely limited. The decision to make use of electrical tabulating machines in handling the results of the field work made possible a broader plan of study. Three states were finally selected: New York, Illinois and Michigan. Within these states the chief areas covered by the field work were the largest cities: New York, Chicago and Detroit. In New York State, Buffalo and Syracuse were included and in addition, most of the cities and towns along the southern and eastern borders and in several interior counties of the state. In Michigan and in Illinois, a few border towns were also studied.

In New York, sixty varieties of retail business and eighty classes of wholesale and manufacturing lines were distinguished. In the other states a classification of business was made on the basis of twenty-seven major groups. Over 30,000 complete returns, each covering from thirty to forty questions, were collected. It is estimated that the final tabulating work on these returns exceeded 200 million unit operations of sorting, counting and entering of totals.

Fortunately, it was agreed at the very outset to tabulate the results mechanically. This made possible a rearrangement of the questionnaire so as to facilitate the transfer of data to standard tabulating cards. In the meantime, a few questionnaires had been circulated by mail and through direct personal

COLUMBIA UNIVERSITY

STUDY ON THE NEW YORK STATE SALES TAX

****

Retailer — Nature of business(i.e.,hats, shoes) _____
Wholesaler — Type of outlet(i.e. independent, branch) _____
Manufacturer
(please check) Address _____

****

1.How large is your store ? (In answering, estimate if necessary)
in terms of : (a) Sales for the year 1932- $ _____ ; % cash____
% credit

(b) Merchandise inventory (December 31, 1932) -- $ _____

(c) Number of employees _____

2.Are you exempt from the State retail sales tax ? Yes..... No.....
3.If so, what is the basis for exemption ? (Check one or more) :
(a) Exempt product: Food..... Gasoline..... Other.....
(b) Receipts derived chiefly from sales of service rather than from sale of tangible articles.....
(c) Taxable revenues for May 1 to June 30, 1933, less than $830....

4.Do you employ a bookkeeper ? ..... Full-time?.....Part-time ?.....
Has this law resulted in increased record keeping costs to you ?
Yes ..... No .....
If so, by how much, approximately ? .....

****

Please answer the following questions only if you are subject to the t

5.Please check one of the following: Do you:
(a) raise prices on each article to all consumers by the exact amount of the tax ? .....
(b) absorb the entire tax burden on all products yourself ?.....
(c) absorb part of the tax and charge the rest to the purchasers? .....
(d) collect the entire tax on total sales by making charges on some articles more than on others ?
---- as a flat percentage ?.....
.....
---- as a variable charge ?.....
(e) Please comment on how this tax has affected your price policy:

_____

_____

6.State reasons why you cannot pass on to the purchaser the full tax on each sale: Because of :
(a) low price of merchandise sold .....
(b) severe competition on certain items .....
(c) customary or well-known advertised prices .....
(d) other considerations.....

FIG. 223
Sample page of retail questionnaire; first draft

RETAIL — COLUMBIA UNIVERSITY _____

STUDY OF THE NEW YORK STATE SALES TAX _____

Nature of business(ie., hats, shoes,grocery, etc.) _____
Type of outlet(ie., whether independent, or branch)----Independent---------- ☐
Branch of main store- ☐
(Please check) Chain store unit----- ☐

1.Do you know that New York State has a retail sales tax ? ------ Yes----- ☐
(Please check) No ----- ☐
2.Are you exempt from this tax ? -- (Please check) ------ Yes----- ☐
If exempt, why ? (Check one or more). The following are No ----- ☐
the bases for exemption:
(a) Exempt products: Food ---------- ☐
Gasoline ---------- ☐
(b) Receipts derived chiefly from sales of service, rather than from sales of tangible articles ---------- ☐
(c) Taxable revenues for May 1- June 30, 1933, less than $ 830 ----- ☐

3.Total number of employees _____ Full-time_____ Part-time _____
Do you employ a bookkeeper or accountant ?----------Yes----- ☐
Full-time?- ☐
Part-time?- ☐
No------ ☐
Has this law resulted in increased record-keeping costs to you ? -Yes----- ☐
No------ ☐
4.Approximate annual sales ? ----- Under $ 5,000 ---------- ☐
$5,000- 9,000 ---------- ☐
10,000- 19,000 ---------- ☐
20,000- 49,000 ---------- ☐
50,000 or over ---------- ☐

Please answer the following questions only if you are subject to the tax.

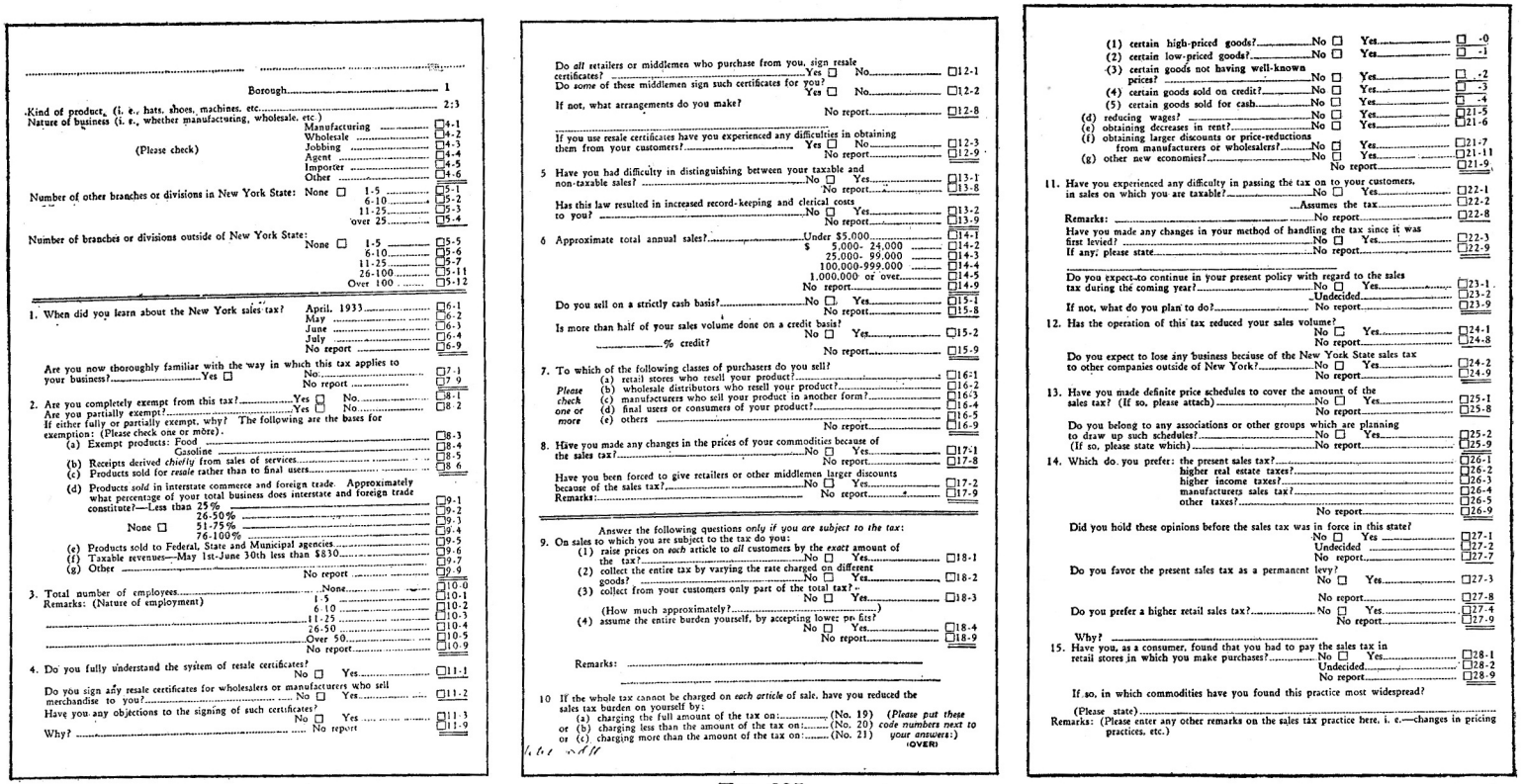
5.A.Have you made any changes in the prices of your commodities because of the sales tax ? Yes- ☐ No-- ☐
B.Do you now:
(1) raise prices on each article to all consumers by the exact amount of the tax ? Yes- ☐ No-- ☐
(2) collect the entire tax by varying the charges on different commodities ? Yes- ☐ No-- ☐
(3) absorb part of the tax, and charge the rest to the purchasers? Yes- ☐ No-- ☐
(4) assume the entire tax burden yourself, by accepting lower profits ? Yes- ☐ No-- ☐

C.Do you expect to continue in this policy with regard to the sales tax during the coming year ? Yes- ☐ No-- ☐

If not, what do you plan to do ? _____

_____

FIG. 224
Sample page of retail questionnaire; second draft



Borough 1

Kind of product, (i. e., hats, shoes, machines, etc. 2-3
Nature of business (i. e., whether manufacturing, wholesale, etc.)

(Please check)

Manufacturing	☐4-1
Wholesale	☐4-2
Jobbing	☐4-3
Agent	☐4-4
Importer	☐4-5
Other	☐4-6

Number of other branches or divisions in New York State:

None ☐	
1-5	☐5-1
6-10	☐5-2
11-25	☐5-3
over 25	☐5-4

Number of branches or divisions outside of New York State:

None ☐	
1-5	☐5-5
6-10	☐5-6
11-25	☐5-7
26-100	☐5-11
Over 100	☐5-12

1. When did you learn about the New York sales tax?

April, 1933	☐6-1
May	☐6-2
June	☐6-3
July	☐6-4
No report	☐6-9

Are you now thoroughly familiar with the way in which this tax applies to your business? Yes ☐ No ☐ No report ☐7-1 ☐7-9

2. Are you completely exempt from this tax? Yes ☐ No ☐ ☐8-1
Are you partially exempt? Yes ☐ No ☐ ☐8-2
If either fully or partially exempt, why? The following are the bases for exemption: (Please check one or more).

(a) Exempt products: Food	☐8-3
Gasoline	☐8-4
(b) Receipts derived *chiefly* from sales of services	☐8-5
(c) Products sold for *resale* rather than to final users	☐8-6
(d) Products *sold* in interstate commerce and foreign trade. Approximately what percentage of your total business does interstate and foreign trade constitute?—Less than 25%	☐9-1
26-50%	☐9-2
None ☐ 51-75%	☐9-3
76-100%	☐9-4
(e) Products sold to Federal, State and Municipal agencies	☐9-5
(f) Taxable revenues—May 1st-June 30th less than $830	☐9-6
(g) Other	☐9-7
No report	☐9-9

3. Total number of employees ..... None ☐10-0
Remarks: (Nature of employment) 1-5 ☐10-1
6-10 ☐10-2
11-25 ☐10-3
26-50 ☐10-4
Over 50 ☐10-5
No report ☐10-9

4. Do you fully understand the system of resale certificates? No ☐ Yes ☐11-1
Do you sign any resale certificates for wholesalers or manufacturers who sell merchandise to you? No ☐ Yes ☐11-2
Have you any objections to the signing of such certificates? No ☐ Yes ☐11-3
Why? ..... No report ☐11-9

Do *all* retailers or middlemen who purchase from you, sign resale certificates? Yes ☐ No ☐12-1
Do *some* of these middlemen sign such certificates for you? Yes ☐ No ☐12-2
If not, what arrangements do you make? No report ☐12-8

If you use resale certificates have you experienced any difficulties in obtaining them from your customers? Yes ☐ No ☐12-3
No report ☐12-9

5 Have you had difficulty in distinguishing between your taxable and non-taxable sales? No ☐ Yes ☐13-1
No report ☐13-8
Has this law resulted in increased record-keeping and clerical costs to you? No ☐ Yes ☐13-2
No report ☐13-9

6 Approximate total annual sales?

Under $5,000	☐14-1
$ 5,000- 24,000	☐14-2
25,000- 99,000	☐14-3
100,000-999,000	☐14-4
1,000,000 or over	☐14-5
No report	☐14-9

Do you sell on a strictly cash basis? No ☐ Yes ☐15-1
No report ☐15-8
Is more than half of your sales volume done on a credit basis? No ☐ Yes ☐15-2
.....% credit? No report ☐15-9

7. To which of the following classes of purchasers do you sell?

	(a) retail stores who resell your product?	☐16-1
Please	(b) wholesale distributors who resell your product?	☐16-2
check	(c) manufacturers who sell your product in another form?	☐16-3
one or	(d) final users or consumers of your product?	☐16-4
more	(e) others	☐16-5
	No report	☐16-9

8. Have you made any changes in the prices of your commodities because of the sales tax? No ☐ Yes ☐17-1
No report ☐17-8
Have you been forced to give retailers or other middlemen larger discounts because of the sales tax? No ☐ Yes ☐17-2
Remarks: No report ☐17-9

Answer the following questions *only if you are subject to the tax*:

9. On sales to which you are subject to the tax do you:

(1) raise prices on *each* article to *all* customers by the *exact* amount of the tax? No ☐ Yes	☐18-1
(2) collect the entire tax by varying the rate charged on different goods? No ☐ Yes	☐18-2
(3) collect from your customers only part of the total tax? No ☐ Yes	☐18-3
(How much approximately?)	
(4) assume the entire burden yourself, by accepting lower profits? No ☐ Yes	☐18-4
No report	☐18-9

Remarks: .....

10 If the whole tax cannot be charged on *each article* of sale, have you reduced the sales tax burden on yourself by:
(a) charging the full amount of the tax on:..... (No. 19) *(Please put these*
or (b) charging less than the amount of the tax on:..... (No. 20) *code numbers next to*
or (c) charging more than the amount of the tax on:..... (No. 21) *your answers:)*

(OVER)

(1) certain high-priced goods? No ☐ Yes	☐ -0
(2) certain low-priced goods? No ☐ Yes	☐ -1
(3) certain goods not having well-known prices? No ☐ Yes	☐ -2
(4) certain goods sold on credit? No ☐ Yes	☐ -3
(5) certain goods sold for cash. No ☐ Yes	☐ -4
(d) reducing wages? No ☐ Yes	☐21-5
(e) obtaining decreases in rent? No ☐ Yes	☐21-6
(f) obtaining larger discounts or price-reductions from manufacturers or wholesalers? No ☐ Yes	☐21-7
(g) other new economies? No ☐ Yes	☐21-11
No report	☐21-9

11. Have you experienced any difficulty in passing the tax on to your customers, in sales on which you are taxable? No ☐ Yes ☐22-1
Assumes the tax ☐22-2
Remarks: No report ☐22-8
Have you made any changes in your method of handling the tax since it was first levied? No ☐ Yes ☐22-3
If any; please state ..... No report ☐22-9

Do you expect to continue in your present policy with regard to the sales tax during the coming year? No ☐ Yes ☐23-1
Undecided ☐23-2
If not, what do you plan to do? No report ☐23-9

12. Has the operation of this tax reduced your sales volume? No ☐ Yes ☐24-1
No report ☐24-8
Do you expect to lose any business because of the New York State sales tax to other companies outside of New York? No ☐ Yes ☐24-2
No report ☐24-9

13. Have you made definite price schedules to cover the amount of the sales tax? (If so, please attach) No ☐ Yes ☐25-1
No report ☐25-8
Do you belong to any associations or other groups which are planning to draw up such schedules? No ☐ Yes ☐25-2
(If so, please state which) ..... No report ☐25-9

14. Which do you prefer: the present sales tax? ☐26-1
higher real estate taxes? ☐26-2
higher income taxes? ☐26-3
manufacturers sales tax? ☐26-4
other taxes? ☐26-5
No report ☐26-9

Did you hold these opinions before the sales tax was in force in this state? No ☐ Yes ☐27-1
Undecided ☐27-2
No report ☐27-7
Do you favor the present sales tax as a permanent levy? No ☐ Yes ☐27-3
No report ☐27-8
Do you prefer a higher retail sales tax? No ☐ Yes ☐27-4
No report ☐27-9
Why? .....

15. Have you, as a consumer, found that you had to pay the sales tax in retail stores in which you make purchases? No ☐ Yes ☐28-1
Undecided ☐28-2
No report ☐28-9

If so, in which commodities have you found this practice most widespread?

(Please state) .....
Remarks: (Please enter any other remarks on the sales tax practice here, i. e.—changes in pricing practices, etc.)

FIG. 225

Sample pages of questionnaire for wholesalers and manufacturers; final draft

canvass by staff members. Several obvious defects were eliminated and a new form was prepared—so arranged that all answers could be inserted in the right hand margin. (See sample page, Fig. 224.)

At this stage, a representative of the Service Bureau of the International Business Machines Corporation was called in to advise and assist in laying out the complete schedule of tabulation. About five hundred sample questionnaires in the revised form had been sent out, and on the basis of replies received a final questionnaire form was devised. Careful attention was given to the order of arrangement of questions so that, by a mere process of checking against certain indicated answers, a significant set of results might be drawn off. Each reply was assigned a characteristic code number which corresponded to the columns and rows on a standard punch-card. Separate questionnaires were made for retailers and for wholesalers and manufacturers. (See Fig. 225.)

Because of the variations in the tax laws of the several states individual forms were devised for each state. In general, however, the questionnaires all followed the same basic form.

Several questions were of such a character that they defied arbitrary classification in advance. These were, therefore, not assigned a code number, but provision was made for the insertion of code numbers by hand as a part of the work of editing the field reports.

Field workers were given a series of talks before starting on their assignments. These lectures were supplemented by detailed mimeographed instructions explaining each item on the questionnaires. Each day, as the field workers' reports were returned, they were edited for any omissions, careless entries, or obvious contradictions in the data. Each return was stamped with the date, and properly coded according to date and geographic area.

The completed forms were then ready for tabulating. Punch operators read the coded information recorded on the questionnaires and transferred these data to the cards used in conjunction with the tabulating machines.

From this stage, the sorting and counting were handled entirely by the Service Bureau of the International Business Machines Corporation. Tabulation report sheets had been prepared in such a way that the coded information drawn from the tabulating machines could be inserted directly by code number—the meaning of each class of information being designated to the right of the codes. (See Fig. 226.)

The careful planning of the questionnaire and provision for codification of the replies at the very beginning of the study was well repaid in the later handling of the data. As the returns came in, the uniformity in arrangement and the standardization which had been achieved made possible an almost complete mechanical treatment in preparing statistical summaries. This enabled the research staff to devote more time and effort to the analysis and interpretation of the reported results.

Many interesting combinations of answers and of various classes of data

COLUMBIA SALES TAX STUDY. — TABULATION REPORT SHEET

Not Exempt

LOCATION

Number Reported

1. _____ ( ) in _____.

NATURE OF BUSINESS

2-8 _____ ( ) _____

TYPE OF OUTLET

4-1 _____ Independents
4-2 _____ Branches
4-3 _____ Chain Store units
4-4 _____ Department stores

SIZE OF BUSINESS (Annual Sales)

11-1 _____ under $5,000
11-2 _____ $5,000-9,000
11-3 _____ 10,000-19,000
11-4 _____ 20,000-49,000
11-5 _____ 50,000 or over
11-9 _____ No report

SIZE OF BUSINESS (No. of Employees)

(Col. 7) Full-time Employees — Number	(Col. 8) Part time Employees — Number
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8 or more
9 or more	9. No report

HEARD OF SALES TAX

5-1 _____ in April, 1933
5-2 _____ in May
5-3 _____ in June
5-4 _____ in July
5-5 _____ in August
5-9 _____ did not report

EXEMPTION STATUS

6-1 _____ are not completely exempt
6-2 _____ are not partially exempt
_____ are partially exempt
6-3 _____ are exempt a/c of food
6-4 _____ " " " of gasoline
6-5 _____ " " " of service
6-6 _____ " " " of low revenue
6-7 _____ " " " other reasons
6-9 _____ did not report

ACCOUNTING INFORMATION

9-1 _____ employ full-time accountant
9-2 _____ employ part-time accountant
9-3 _____ employ no accountant
9-9 _____ did not report

10-1 _____ reported increased record-keeping costs
10-8 _____ did not report
10-2 _____ had no difficulty in distinguishing taxable sales
10-9 _____ did not report

12-1 _____ sell on a strictly cash basis
12-8 _____ did not report
12-2 _____ reported credit sales of over 50%
12-9 _____ did not report

ATTITUDE ON SALES TAX

21-1 _____ preferred present sales tax
21-2 _____ preferred higher real estate taxes
21-3 _____ preferred higher income taxes
21-4 _____ preferred other taxes
21-9 _____ did not report

22-1 _____ held same opinion before
22-7 _____ did not report
22-2 _____ prefer tax as permanent levy
22-8 _____ did not report
22-3 _____ prefer higher sales tax
22-9 _____ did not report

CONSUMER VIEWPOINT

23-1 _____ had to pay tax in other stores
23-2 _____ did not know
23-9 _____ did not report

FIELD WORKERS' REMARKS

24-1 _____ stores in good neighborhood
24-2 _____ " " fair "
24-3 _____ " " poor "
25-1 _____ dealers were American type
25-2 _____ " " Italian "
25-3 _____ " " Jewish "
25-4 _____ " " German "
25-5 _____ " " Colored "
25-6 _____ " " other types
26-1 _____ answers considered reliable
26-2 _____ " " doubtful
26-3 _____ " " unreliable
26-4 _____ said they were mulcted

The following applies only to those who are not exempt or who are partially exempt from the tax:

CHANGES IN PRICE POLICY

13-1 _____ changed price a/c of tax
13-8 _____ did not report
13-2 _____ raise cash article by exact tax
13-3 _____ collect entire tax but vary rate
13-4 _____ collect only part of tax
13-5 _____ assume entire tax burden
13-9 _____ did not report
14-1 _____ made changes in handling tax
14-8 _____ did not report
14-2 _____ do not expect to continue present tax policy during coming year
14-3 _____ are undecided what to do
14-9 _____ did not report

The following reasons were given for assumption of tax:

15-12 _____ because of customers resentment
15-11 _____ because of low price of mdse.
15-0 _____ " " high price of mdse.
15-1 _____ " " well-known prices
15-2 _____ " " severe competition

The following reasons were given for difficulty encountered in charging tax:

15-4 _____ because of customers' resentment
15-5 _____ " of low price of mdse.
15-6 _____ because of high price of mdse.
15-7 _____ " " well-known prices
15-8 _____ " " severe competition
15-5 _____ stated other reasons for above
15-9 _____ did not report

Those who cannot tax *each* article of sale, said they reduced the tax burden by the following method:

They charge:

The tax in full (Col. 16)	*Less than the tax* (Col. 17)	*More than the tax* (Col. 18)	on certain goods
0			having high prices
1			having low prices
2			not having well-known prices
3			sold on credit
4			sold for cash

18-5 _____ reduced wages because of the tax
18-6 _____ obtained decreases in rent because of the tax
18-7 _____ obtained larger discounts from manufacturers or wholesalers
18-8 _____ made other economies
18-9 _____ did not report

PRICE SCHEDULES

19-1 _____ made definite price schedules
19-8 _____ did not report
19-2 _____ belong to assoc. which plan to draw up such schedules
19-9 _____ did not report

LOSS OF BUSINESS

20-1 _____ reported loss of sales volume because of the tax
20-8 _____ did not report
20-2 _____ lost business to mail order houses
20-3 _____ " " to out-of-state companies
20-4 _____ lost business to competitors who do not add tax to prices
20-5 _____ lost business to other competitors
20-9 _____ did not report

FIG. 226

were prepared. Some of these follow:

(1) Replies of all retail stores in the same line of business were grouped together and separately classified.
(2) A similar arrangement was made among wholesalers and manufacturers.
(3) Returns were divided into exempt and non-exempt classes.
(4) Replies were classified according to the size of business units.
(5) Answers were separated according to geographic areas.
(6) All returns indicating that the business shifted the sales tax were cross-tabulated with ten or twelve other pertinent replies.
(7) Returns indicating that dealers assumed the tax burdens themselves were similarly cross-tabulated.
(8) Cross-tabulations were also made with reference to time at which the questionnaire was received, changes in policy in handling the tax, and consumer attitude with respect to the tax.

The ability to form comparisons of this sort, and to correlate one group of facts with another makes possible a series of conclusions which the most careful inspection of the data as a whole would not reveal.

Modern methods of machine tabulation may thus be regarded as important tools which are available for the handling of certain classes of economic data. Through the facilities which they afford in large statistical projects of the variety outlined above, they often make possible a series of operations which otherwise could not reasonably have been performed in any other way. To this extent, at least, such machinery serves as part of the auxiliary equipment of the modern research worker in the field of economics.

PART IX

Miscellaneous Research Applications

CHAPTER IV

Literature

By
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Associate Professor of English and Associate Dean of the College of Liberal Arts and Sciences, University of Illinois

THERE are many problems in the intensive study of literature that call for listing and tabulation. One of these is the problem of index making, especially those time consuming word indexes of an author's works. The usefulness of such indexes is, of course, the usefulness of a tool and like all tools they depend entirely on their reliability. Insofar as machine operations can be substituted for manual operations in index making, the degree of reliability of the finished product can be considerably raised.

For several years the need for a word index of Milton's English prose works has been apparent. Without such an index we know little about his use of the language, and there is no way of being certain of the contents—ideas, proper names, authors used, or nature of the vocabulary—of the thousand or more pages that constitute Milton's English prose writings.

The preparation of word indexes and of concordances involves a great deal of manual labor. The time involved often extends into years. Both of the above factors tend to discourage such works. To overcome these discouragements and to increase the degree of accuracy an investigation was made into the possibility of using the new alphabetic tabulating equipment in connection with index work. This investigation resulted in the adoption of the technique as described in the following pages.

A tabulating card (Fig. 227) is punched for each word of the text. An alphabetic duplicating key punch is used. The card used has fields for the following information:

Word Recurrence, Column 1

A 1 is punched for each word that occurs in the text. If, for example, the explanatory context should take more space than is allotted, a second card is used for the rest of the context. This card has to contain all of the same reference information that the first card contains. This is necessary in order to have it sort with the original card. When a count is made to determine the frequency of a word, the use of the card-count would register two for this word. To prevent this 0 is punched in this

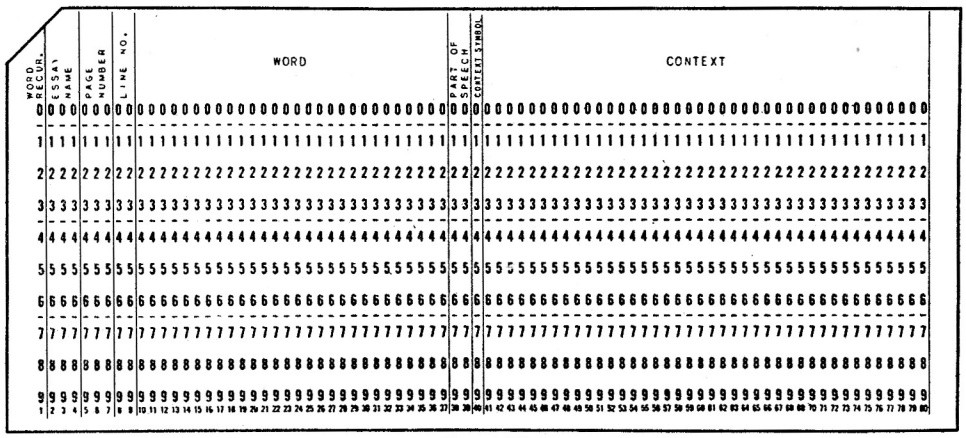

FIG. 227

Tabulating Card used in preparation of Word Index

field in the second card. In this way an accurate count is obtained by adding or counting the 1's punched.

Essay Name, Columns 2 to 4

In this field is punched in alphabetic characters the abbreviation of the name of the essay studied.

Page Number, Columns 5 to 7

The pages are numbered separately for each essay, and this number is punched as a reference.

Line Number, Columns 8 to 9

The number of the line on which the word occurs is punched in this field.

Word, Columns 10 to 37

The word as found in the text is punched in this field. Archaic words can in most cases have the modern spelling in this same field. If the space is not sufficient, a second card is used in which case the procedure under column 1 is followed.

Part of Speech, Columns 38 and 39

A code is used to indicate in this field the part of speech and other information such as tense or number of the word concerned.

Context Symbol, Column 40

Whenever the context is to be punched on the card, the number 1 is punched in this field, otherwise the 0 is punched. The alphabetic tabulator can print 43 alphabetic characters on one line at one operation. If the context were given for each word, a second run of the cards would be made to print the context. In this way a total of 86 letters can be printed on one line. Obviously, if the context is included for each word, no context symbol is needed. In this study the context will be given only for certain archaic or unusual words. The context symbol printed on the first run will show where the context is to be printed.

One sort on this field will select the cards on which the context is included, without destroying their sequence. They can then be listed for the printer on a separate sheet or they can be listed on the sheet on which the first was printed. A line will be printed only where a context symbol appears. This procedure eliminates the necessity of putting through the machine a second time thousands of cards which have no context.

Context, Columns 41 to 80

The immediate context is punched in this field. The word for which the context is given is indicated only by the initial letter followed by two spaces. If the context must include more than forty spaces, a second card will have to be used following the procedure indicated under column 1.

The card representing the first word of a page is used as a master card from which columns 1 to 7 are duplicated on all subsequent cards for that page. Care must, of course, be taken to raise the duplicating rack of the punch whenever a zero is to be punched in column 1.

To verify the work of the punch operators a run of the cards is made in the same sequence as they were punched from the text. This list can then be proof read against the original text.

After the corrections have been made the cards are sorted alphabetically. In sorting alphabetically the procedure would ordinarily be to sort from right to left over the whole field. In this study a sort will probably be made on the eighth or ninth letter from the left. All cards having words of more than eight or nine letters will fall into the reject pocket. This small group of cards can then be sorted alphabetically from the right to the column on which the first sort is made. Then they can be included with the rest of the cards and the sorting completed.

The listing of the cards is a simple operation. The various fields on the card are connected with the printing mechanism to print the words and reference data in any desired arrangement. As stated before the context is listed by putting the cards through the machine a second time. An example of such a list is shown in Fig. 228.

The great appeal of this method to the indexer is obvious. In the making of a word index the production of the original cards or the writing of each word on a card together with its place of occurrence and other supplementary material constitutes only twenty to twenty-five per cent of the total procedure necessary to secure the finished index. I should estimate that not over five per cent of the time required for the original making of the cards can be saved through the use of tabulating machinery. However, once the separate words are punched on tabulating cards and verified, the balance of the whole process of indexing is completely taken over by the sorting and tabulating machines. It is here that the amount of time saved may well rise as high as eighty per cent. In the past the operations of hand sorting and alphabetizing have been very slow and relatively inaccurate. If any duplication was required, the chance

Word	Part of Speech	Essay	Page	Line	Context Symbol	Context
ABILITY	21	ED	276	06		
ABILITY	21	ED	280	24		
ABLE	60	ED	286	25		
ABOVE	60	ED	275	03	1	MEANING MORE THAN
ABOVE	60	ED	282	23		
ABROAD	60	ED	290	05	1	MEANING IN THE COUNTRY
ABROAD	60	ED	291	09	1	MEANING AT LARGE
ABSOLUTE	60	ED	281	02		
ACADEMIES	22	ED	287	27		
ACADEMY	21	ED	280	21		
ACCENT	21	ED	286	01		
ACCEPT	10	ED	276	26		
ACCESS	21	ED	283	11		
ACCORDING	30	ED	286	05	1	A TO
ACCORDING	30	ED	289	10	1	A TO
ACCORDING	30	ED	288	05	1	A AS THEIR RISING IN THE MORNING
ACCOUNT	21	ED	278	21		
ACT	21	ED	284	15		
ACTIONS	22	ED	275	16		
ACTS	22	ED	278	04		
ADMIRATION	21	ED	282	04		
ADMIRED	50	ED	290	21	1	THOSE OLD VIRTUES
ADOE ADO	21	ED	280	07		
ADORN	10	ED	288	26		
ADVANCE	10	ED	290	19		
ADVANTAGE	21	ED	290	22		
AFFAIRS	22	ED	279	16		
AFFECTIONS	22	ED	284	21		
AFFORDS	10	ED	277	13		
AFTER	30	ED	277	16		
AFTER	30	ED	278	13		
AFTER	30	ED	281	03		
AFTER	30	ED	282	17		
AFTER	30	ED	282	18		
AFTER	30	ED	283	07		
AFTER	30	ED	285	01		
AFTER	30	ED	289	04		
AFTER	30	ED	290	09		
AFTERWARDS	60	ED	288	04		
AGAIN	60	ED	290	21		
AGAIN	60	ED	290	25		
AGAINST	30	ED	278	09		
AGAINST	30	ED	290	07		
AGE	21	ED	280	13		
AGE	21	ED	289	11		
AGE	21	ED	290	27		
AGE	21	ED	291	27		
AGES	22	ED	278	24		
AGES	22	ED	282	06		

FIG. 228
Tabulator Tape showing list of words in alphabetic order

for error was frequently appalling. Thus, the second element that is gained through the use of the punched card method—accuracy—cannot be overrated. With the human element and the time element both concentrated on the making of the original cards, the limitation of error should be very pronounced. The whole process will, I believe, proceed at a pace and with a degree of accuracy that will make indexing by hand seem extraordinarily time consuming and obsolete.

PART IX

Miscellaneous Research Applications

CHAPTER V

Social Science

By
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FOR purposes of administration unity in carrying on the researches in the field of the social sciences, there was established at this University a Department of Social Science. The special disciplines of economics, sociology, anthropology and education, thus, have the advantage of common facilities for work as well as the material benefit and inter-stimulation of all the social studies in process. Since the establishment of the Department in 1929, there have been undertaken seventeen major research projects: nine in sociology, two in education, two in economics, two in anthropology and two general studies. Two of these studies have been initiated at the request of the Social Science Research Council, one for the General Education Board, two for the Julius Rosenwald Fund, and one for the Tennessee Valley Authority.

In most of these studies the statistical features have loomed large. The researches call for the rapid and accurate tabulation of data from questionnaires, schedules, and a wide variety of records from institutions. A great part of these data lend themselves to definite and accurate statement and therefore can be classified and coded for the punched card.

Obviously the volume of this work required dependable mechanical assistance. Tabulating machines were installed in 1930 and they have been continuously in operation since. For a brief period prior to 1930, we farmed out these tabulations, but were soon convinced that for greatest convenience to our own methods of work it would be better to train operators from our own staff, and to allow the machines to become the structure of a statistical department. In the end economies were effected both in the cost of tabulations and in the administration of the researches.

Distinct advantages from the experience with mechanical tabulation have been revealed in line with the ultimate educational function of the institution. In the first place, it permits the research assistants, graduate and advanced undergraduate students, to become acquainted with the techniques of mechanical tabulation. Again, in the funding of the data from these social studies it is possible not only to develop detailed cross relationships of particular investigations, but without great difficulty to test the relationship of common features of several studies.

The use of the punched card in the compilation of data is illustrated in certain of the studies of the department indicated below:

Mining Study

This study is the basis of the book, "The Plight of the Bituminous Coal Miner," by Dr. Homer L. Morris. The field work of investigations for the study was carried on by means of a detailed schedule which was made up of nearly 80 items. The tabulation of these items was accomplished by the use of a set of nine cards. The following is an illustration of the arrangement of the data on the cards. (Fig. 229.)

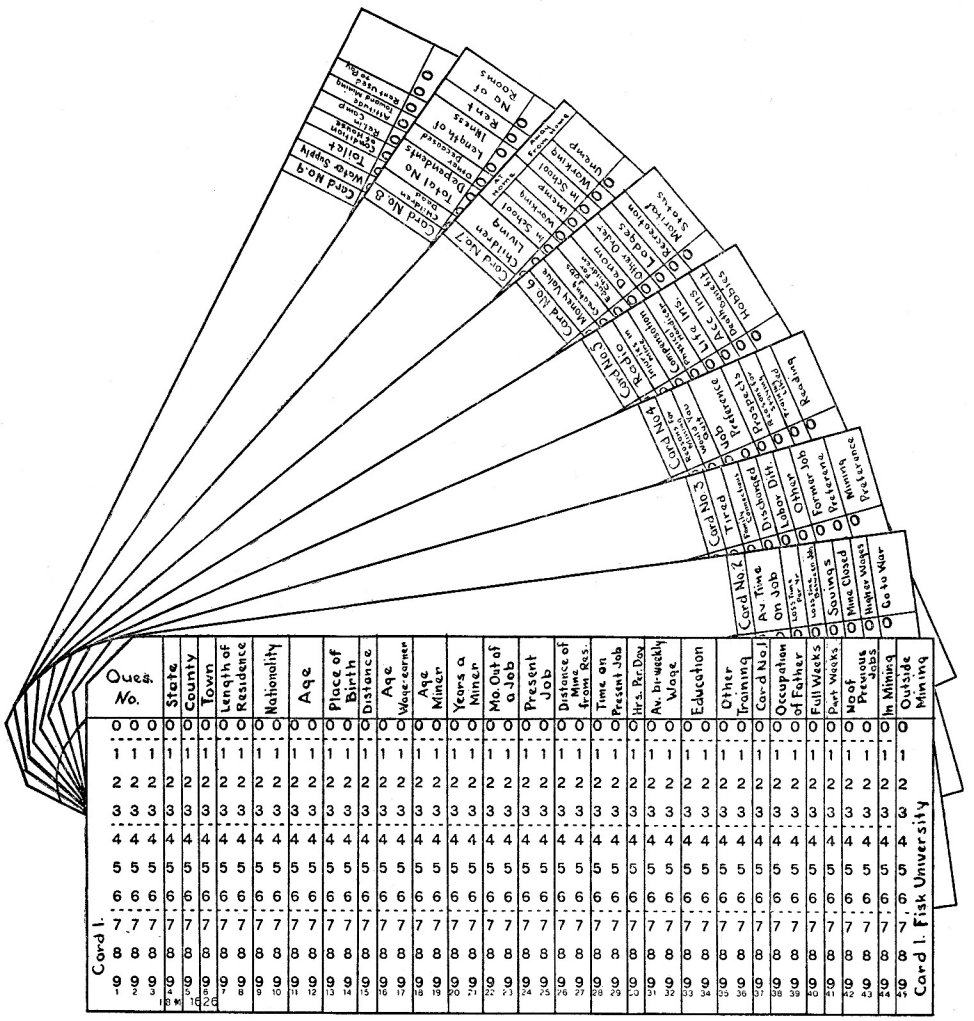

FIG. 229

Rural Studies

"Shadow of the Plantation," University of Chicago Press, 1934, by Charles S. Johnson, is one of the rural studies in a larger series. These studies were begun with the view of assembling material on the social and

cultural life of the Negro in southern rural areas. Much of the data secured in course of the studies was adaptable to tabulation by means of the punched card system. An illustration of the arrangement of the material for the card follows. (Fig. 230.)

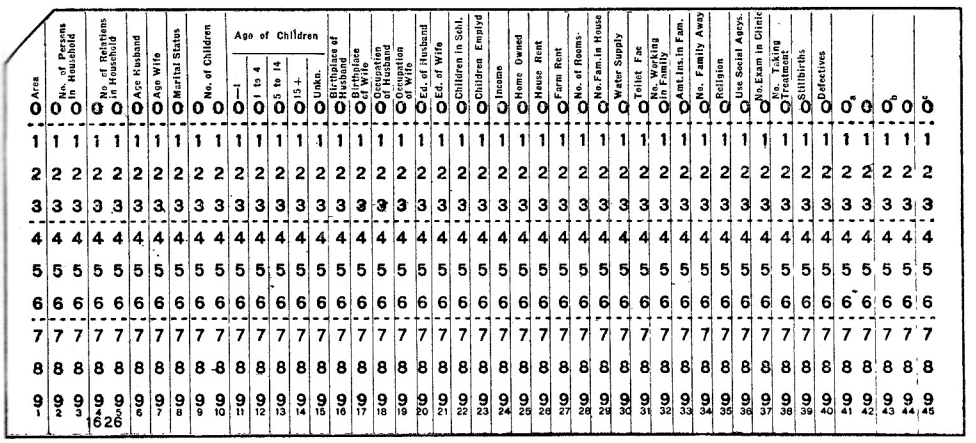

FIG. 230

Negro Family Studies

In the study of the Negro family in the United States, which is being carried on by Dr. E. Franklin Frazier, machine tabulations have been almost indispensable. An important phase of these studies has made use of material secured from the United States Bureau of the Census. Detailed original material not available in the census publications, covering 13,000 Negro families, was taken from the original census records and transferred to special cards through code numbers. (Fig. 231.) The routine of punching and tabulating these cards was carried on in the tabulating offices of the Department of Social Science at Fisk University.

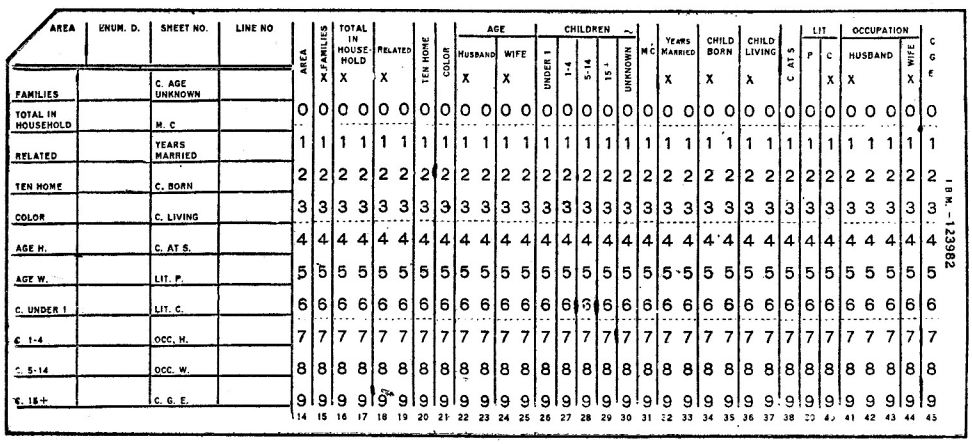

FIG. 231

T. V. A. Surveys

The purpose of these studies was to assemble a considerable body of data

on the social and economic status of the Negro population in the Tennessee Valley.

The study fell, naturally, into two parts: (1) the investigation of the urban Negro population, and (2) the investigation of the rural Negro population. For both phases of this study a separate major schedule was constructed for use in the compilation of the data. Both schedules were designed for tabulation by means of the Hollerith punching machine system. They covered a total of 6,000 families. (Figs. 232, 233 and 234.)

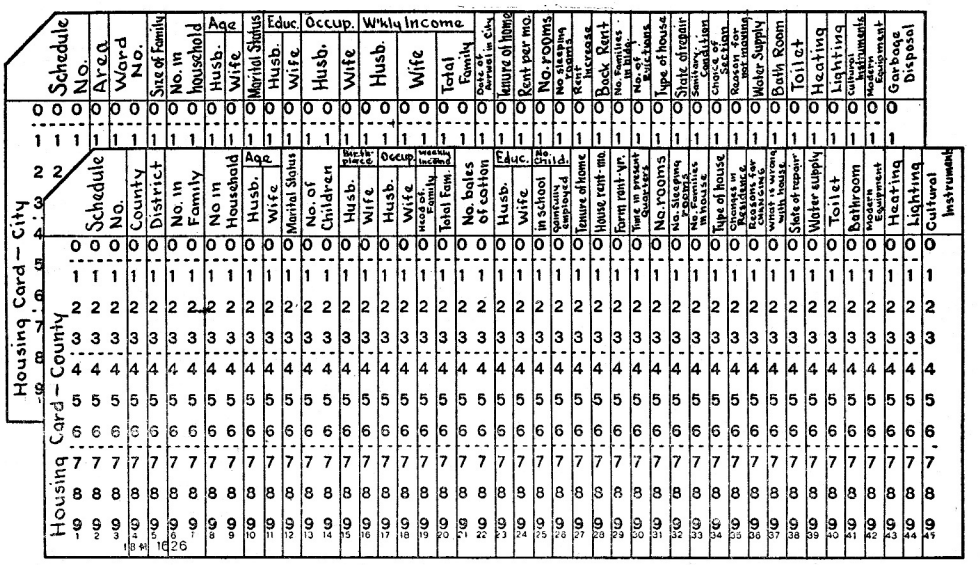

FIG. 232

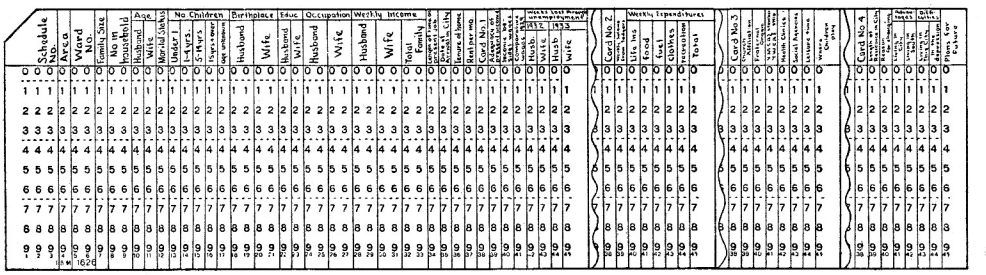

FIG. 233

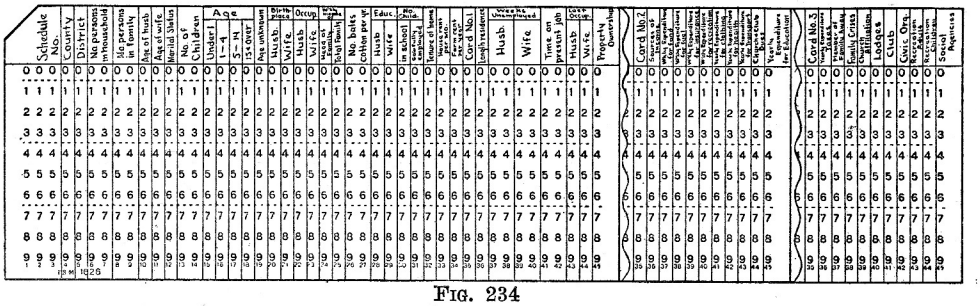

FIG. 234

In connection with the urban studies, data from the records of institutions were secured by means of special forms from which the information could readily be transferred to punched cards. (Fig. 235.)

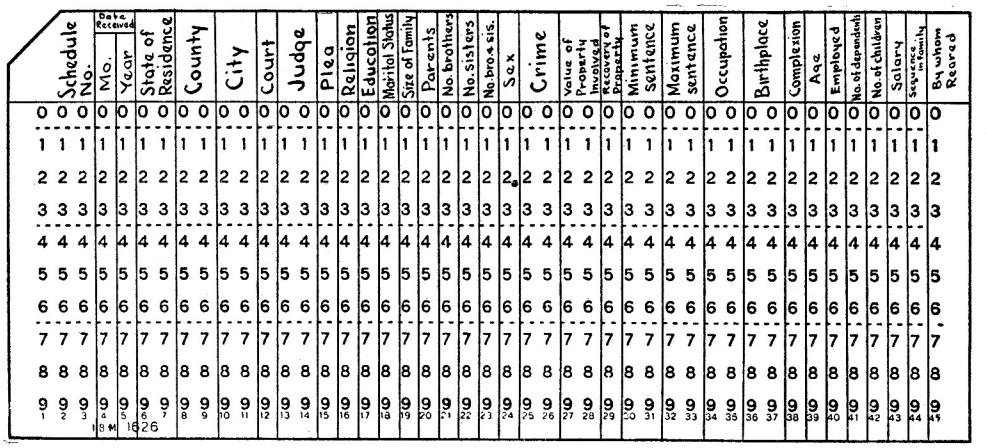

FIG. 235

Attitude Study

The study of social attitudes was an attempt to measure quantitatively as well as qualitatively racial attitudes, and involved the development of a scale and the direct and cross tabulation of 134 items from 6,000 questionnaires. (Fig. 236.)

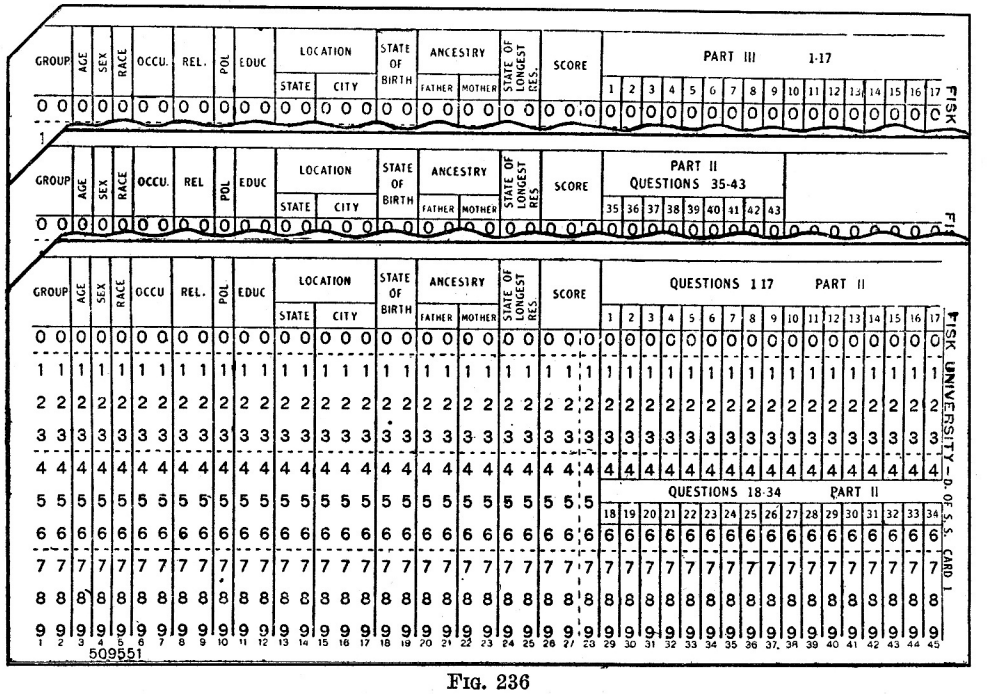

FIG. 236

The punched card in this instance was utilized to relate the various scores to environmental factors, educational levels, interests, and the section of the country in which the subjects reside.

Study of Negro College and Professional Graduates

In course of this study data from many sources were prepared for use by means of the punched card system. (Fig. 237.)

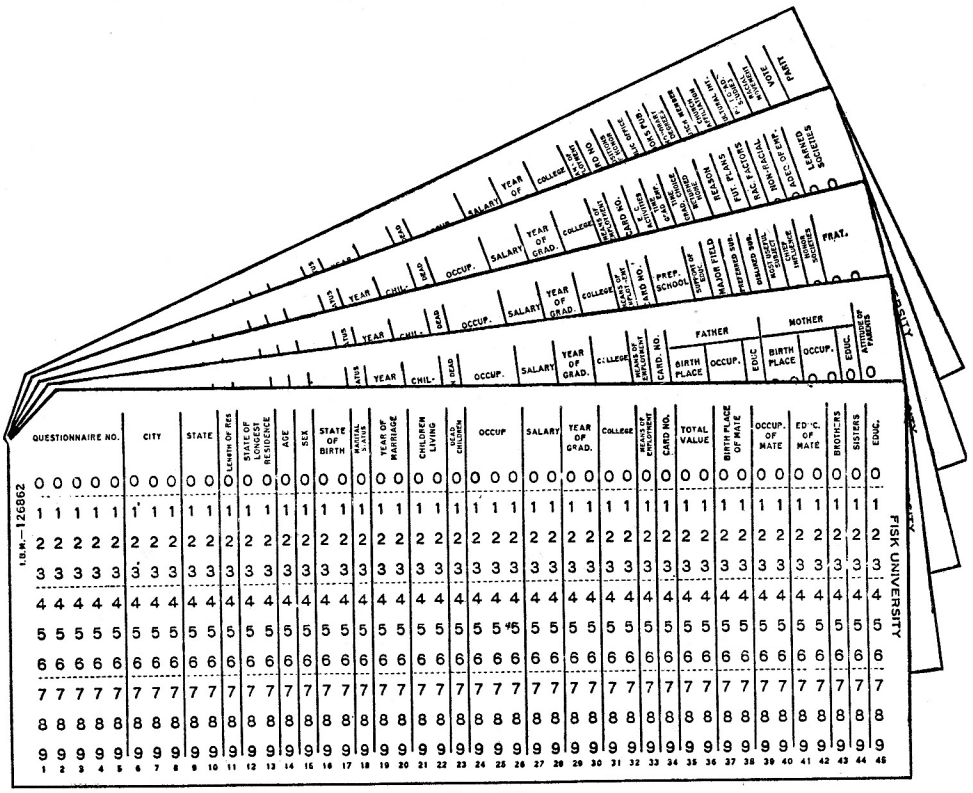

FIG. 237

This study was reserved for final discussion of the application of the punched card system because it affords many unique examples of the part this system plays in the preparation of statistical materials.

Once the data from questionnaires have been transferred to cards by means of the punched hole, important relationships between specific items in the data could be determined. For example, it was possible to secure some indications of the mobility of college graduates, by cross tabulating states of birth by states of residence with the states in both instances arranged in the same order; those born and living in the same state appeared on the table along a straight line running diagonally across the table. In the same manner a correlation between incomes and value of property could be revealed in a scatter diagram when these two items are cross tabulated.

The very considerable volume of the tabulations, the demand for promptness and accuracy, the distinct aid to analysis of quick comparisons, and the testing of obscure relationships, make these machines invaluable to any effective research which involves figures.

PART X

Applications of Specific Methods to the Solution of Statistical Problems

PART X

Applications of Specific Methods to the Solution of Statistical Problems

CHAPTER I

Uses of the Automatic Multiplying Punch

By
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THE recent development of the Automatic Multiplying Punch is unquestionably the most important contribution to the mechanics of mathematical statistics since the invention of adding and multiplying machines. By enabling one to compute moments and product-moments exactly and without the grouping of variates about class-marks, corrections such as those due to Sheppard are unnecessary for practical computations. Indeed, it is even possible to evaluate linear functions of one or more variables with this machine, and subsequently print the graduated values on a scroll—these results being "rounded off" to any desired number of decimal places.

In order to provide an actual problem to serve as an illustration, I secured the anthropometric records of one thousand first year male students who entered the University of Michigan in the fall of 1928. The 1,000 cards, of which Fig. 238 is a sample, were punched by an operator of average ability in slightly less than three hours.

A standard alphabetic printing punch was used that both prints the words or numbers on each card and also translates the information into properly punched holes in the card.

The data for the students were selected at random and the cards, as punched, were numbered consecutively from 1 to 1,000,—the card selected for Fig. 238 being the 275th. The weight to the nearest pound of this individual was 125 pounds, and the height, width of shoulders, and the circumferences of chest, waist, hips and right thigh were, respectively, 64.0, 16.8, 34.2, 26.0, 34.3 and 20.2,—linear measurements being made to the nearest one-tenth inch.

These 1,000 cards may now be placed in a tabulating and listing machine which can total all seven of the data fields simultaneously. If desired, the machine will also print all of the information of each card on a scroll together with the totals. The first and last parts of this scroll are reproduced photographically (Fig. 239)—the names of the individuals being omitted purposely. Because of both the number of columns involved and the magnitudes of the totals, the listed totals unfortunately run together. The vertical lines,

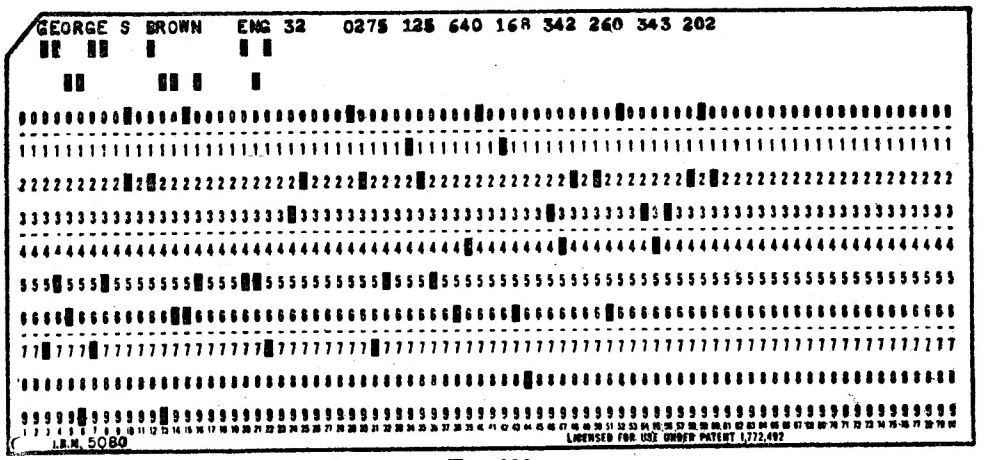


FIG. 238
Sample of tabulating card used in Anthropometric Study

inserted with a pen, facilitate the reading of the totals. The cards are totaled and listed simultaneously at the rate of 80 per minute.

An investigation of the correlation that may exist between height and weight will involve the numerical value of

$$\sum_{i=1}^{1000} x_i y_i$$

where x_i *and* y_i, designate the height and weight, respectively, of the ith individual. The plugboard of an Automatic Multiplying Punch may be wired in a few seconds so that

(a) the data of columns 34, 35 and 36 of Fig. 238 will feed into the multiplier of the punch,

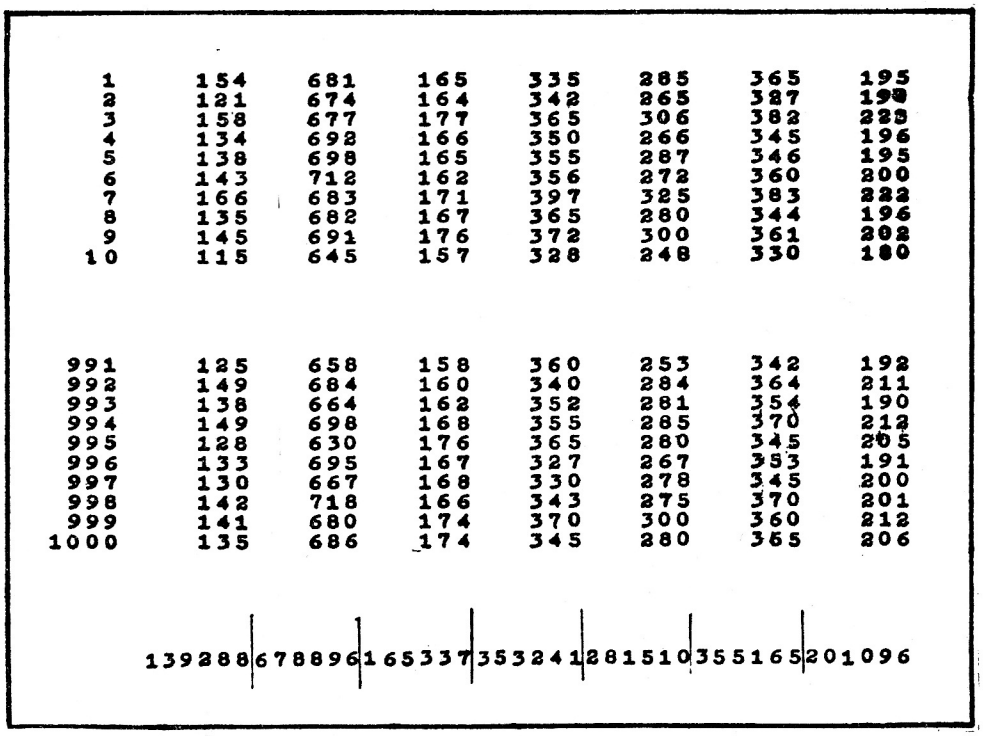
(b) the data of columns 38, 39 and 40 will feed into the multiplicand, and then

(c) the product, xy, for any card run through the machine will appear on the product summary counter. As the cards pass through the machine, the total of the products is accumulated on this counter.

If desired, each product may be punched automatically in the card, provided of course the card contains a sufficiently large number of otherwise vacant columns. The maximum number of digits in current models that may occur in either multiplier or multiplicand is eight. The number of digits in the multiplicand does not affect the speed of the multiplication; for three or less digits in the multiplier the cards feed through the machine at the rate of three seconds per card,—for eight digits in the multiplier the speed is twelve cards per minute. One may therefore place our cards in the machine, press a button, resume other duties, and some fifty minutes later the 1,000 cards will have yielded the total

$$\Sigma xy = 9\ 477\ 433.6$$

To obtain the sum of the squares of the variates in question it is necessary only to double-wire the machine,—one wire going to the multiplier and the



1	154	681	165	335	285	365	195
2	121	674	164	342	265	327	190
3	158	677	177	365	306	382	228
4	134	698	166	350	266	345	196
5	138	698	165	355	287	346	195
6	143	712	162	356	272	360	200
7	166	683	171	397	325	383	222
8	135	682	167	365	280	344	196
9	145	691	176	372	300	361	202
10	115	645	157	328	248	330	180
991	125	658	158	360	253	342	192
992	149	684	160	340	284	364	211
993	138	664	162	352	281	354	190
994	149	698	168	355	285	370	212
995	128	630	176	365	280	345	205
996	133	695	167	327	267	353	191
997	130	667	168	330	278	345	200
998	142	718	166	343	275	370	201
999	141	680	174	370	300	360	212
1000	135	686	174	345	280	365	206

139288 678896 165337 353241 281510 355165 201096

FIG. 239
Section of tabulated list of cards showing totals

other to the multiplicand. We obtain then

$$\Sigma x^2 = 4\ 615\ 312.12 \qquad \Sigma y^2 = 19\ 692\ 452$$

By permitting the machine to punch each value of x^2 in the card, we may treat x^2 as the multiplicand and x as the multiplier and then obtain the sum of the cubes of the variates; or by double-wiring x^2 obtain the sum of the fourth powers of the variates. If, while accumulating the cubes of the variates, we let the machine also punch each cube in the card, we may then obtain the sum of the powers of the variates up to and including that of the sixth order, etc. We are limited, of course, by the fact that the card contains eighty columns.

By running the punched cards through a sorting machine, we may obtain very readily the frequency distribution of the weights, and also the corresponding median, quartiles, etc. To accomplish this the cards must be run through a sorting machine three times, first sorting on column 35 of Fig. 238, then on column 34 and finally on column 33. The cards pass through the sorting machine at the rate of 400 per minute, so that in approximately eight minutes—including time spent in handling the cards between sorts—these 1,000 cards will be perfectly arranged according to magnitude in weight. If the numbers with respect to which the sort is to be made contain N digits, the cards must be run through the sorter N times. We reproduce on the following page a

Card #	Weight	Height	Shoulder	Chest	Waist	Hip	Rt Thigh
232	89	597	140	295	253	305	171
146	100	607	157	300	242	312	170
691	101	690	150	301	245	308	165
358	102	676	154	327	262	322	174
555	102	662	153	303	242	307	165
941	102	640	154	313	262	313	168
209	103	663	154	310	285	313	172
801	103	649	150	302	247	317	168
14	104	638	147	313	253	300	178
513	105	635	148	310	250	328	187
720	105	637	155	330	258	319	178
563	106	648	153	302	245	320	169
672	106	638	162	323	254	320	181
153	107	623	143	317	250	322	172
75	108	630	160	335	245	332	183
235	108	669	157	320	247	324	172
322	108	624	165	305	260	325	188
505	108	637	152	330	246	330	183
31	109	620	161	334	265	340	192
393	109	625	152	314	233	336	187
30	110	631	168	345	265	327	180
160	110	667	153	320	247	322	175
185	110	627	152	323	274	320	172
631	110	630	153	335	255	330	180
802	110	623	149	317	257	328	181
15	111	650	158	312	265	344	194
151	111	637	157	322	258	325	172
273	111	651	156	332	270	326	180
447	111	655	160	314	252	324	176
20	112	696	155	300	230	335	174
426	112	647	154	333	262	328	170
507	112	691	161	323	262	322	180
716	112	667	148	330	254	322	185
831	112	651	147	373	262	333	182
308	113	661	155	318	250	330	180
383	113	665	154	338	240	333	178
449	113	651	151	328	258	311	163
541	113	675	152	316	257	340	186
591	113	650	166	341	265	333	180
826	113	654	147	331	260	333	183
898	113	677	156	320	253	335	187
933	113	656	153	315	240	326	179
947	113	637	146	315	262	337	188
967	113	696	151	320	258	330	169
148	114	654	153	320	247	322	183
177	114	633	160	342	255	321	172
257	114	653	162	318	270	320	185
368	114	679	145	318	243	322	173
462	114	653	153	322	261	321	171
464	114	627	150	310	262	332	180
545	114	612	157	334	260	318	181
741	114	662	161	338	262	338	186
951	114	681	153	311	242	333	174
987	114	667	152	342	250	330	188
10	115	645	157	328	248	330	180
139	115	665	146	332	265	339	188
159	115	636	160	328	297	318	174
336	115	663	153	321	252	323	167
743	115	639	158	322	278	338	182
949	115	686	154	330	242	330	182
970	115	653	152	313	250	337	172
988	115	692	155	330	252	352	172
52	116	640	157	316	260	337	193
186	116	606	159	330	258	337	186
226	116	665	166	341	262	335	185
268	116	636	165	350	265	350	192
347	116	630	163	321	265	325	195
510	116	662	162	337	275	330	190
523	116	695	158	325	243	340	182
926	116	641	154	338	257	340	182

FIG. 240. Section of tabulator tape listing cards according to weight

photograph of the first part of a printed scroll obtained by running the cards through the listing machine after they had been sorted according to weight. (Fig. 240.)

A rough notion of the functional dependence that exists between weight and the other six variables recorded on the cards may be obtained by permitting the machine to total these ordered-with-respect-to-weight cards in consecutive groups of 100. That is, we obtain the averages for numerically equal groups selected according to the weight-deciles. The six regression lines may therefore be plotted, approximately, from the following results:

TABLE 1.

ANTHROPOMETRIC AVERAGES BASED ON WEIGHT DECILES.

Inter-decile Range	*Weight*	*Height*	*Sh'der*	*Chest*	*Waist*	*Hips*	*Rt.Th.*
First	112.98	65.133	15.576	32.607	25.748	32.968	18.133
Second	122.41	66.659	15.980	33.663	26.777	33.927	18.926
Third	127.85	67.087	16.161	34.421	26.978	34.387	19.206
Fourth	131.98	67.381	16.334	34.816	27.622	34.858	19.554
Fifth	135.62	67.937	16.406	34.860	27.954	35.081	19.893
Sixth	139.54	68.189	16.651	35.608	28.065	35.511	20.112
Seventh	143.87	68.576	16.789	35.766	28.513	36.006	20.438
Eighth	149.43	68.895	16.807	36.116	28.780	36.420	20.712
Ninth	156.01	69.185	17.022	36.788	29.537	37.181	21.444
Tenth	173.19	69.854	17.611	38.596	31.536	38.826	22.678

If we had arranged the cards numerically with respect to height, instead of weight, we would have obtained the following results:

TABLE 2.

ANTHROPOMETRIC AVERAGES BASED ON HEIGHT DECILES

Inter-decile Range	*Weight*	*Height*	*Sh'der*	*Chest.*	*Waist*	*Hips*	*Rt.Th.*
First	123.95	63.339	16.036	34.201	27.371	34.217	19.592
Second	130.97	65.295	16.261	34.856	27.984	34.944	19.929
Third	133.75	66.367	16.282	34.787	27.731	35.152	19.926
Fourth	136.28	67.021	16.570	35.429	28.329	35.302	20.084
Fifth	139.81	67.623	16.587	35.379	28.206	35.499	20.223
Sixth	140.60	68.189	16.532	35.510	28.184	35.560	20.008
Seventh	142.65	68.806	16.659	35.550	28.380	35.821	20.315
Eighth	143.44	69.498	16.638	35.328	28.065	35.858	20.205
Ninth	145.71	70.412	16.776	35.778	28.236	35.960	20.068
Tenth	155.72	72.346	16.996	36.423	29.024	36.852	20.746

A comparison of tables 1 and 2 reveals clearly that the right thigh measurements are more highly correlated with weight than with height and this phenomena appears also to be true—though possibly less pronounced—for the shoulder, chest, waist and hip measurements.

TABLE 3.
RELATIVE FREQUENCY OF FINAL DIGITS IN OBSERVED VARIATES.

Final Digit	*Frequency*
0	142
1	69
2	117
3	84
4	108
5	112
6	112
7	69
8	117
9	70
Total	1000

By sorting the cards according to the last recorded digit of each weight, the tendency of observers to state results as multiples of two and five is apparent. The results presented in table 3 indicate that final digits of 1, 3, 7 and 9 are decidedly unpopular and this casts a reflection upon the accuracy of the recorded measurements. This type of bias is well known—in fact, census and mortality statistics usually present the same phenomena. Fig. 241, which follows, clearly illustrates this fact.

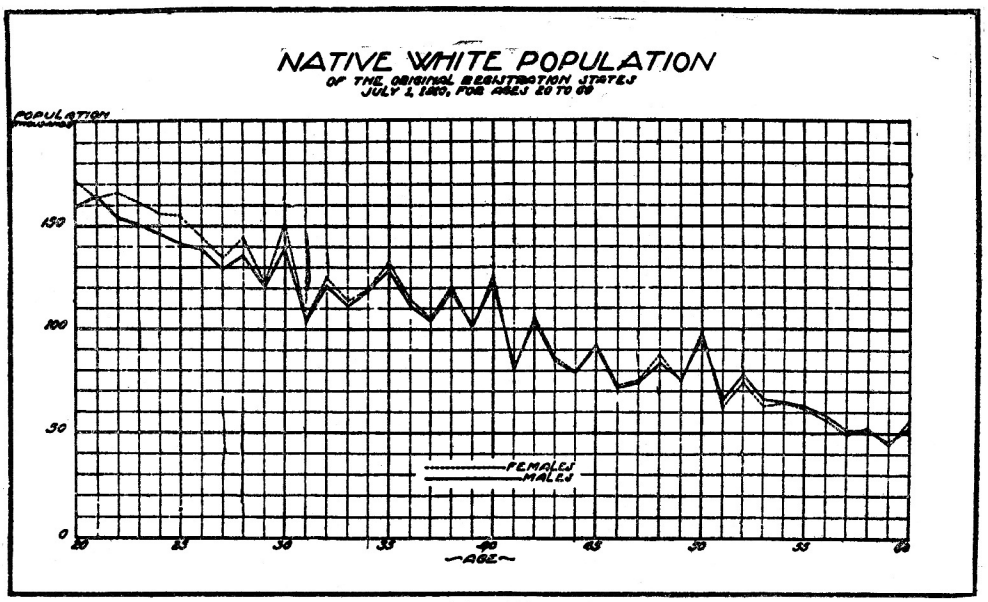


FIG. 241

To sum up: The punching sorting and listing machines provide a most economical and accurate method of recording and analyzing, non-mathematically, observational data. The punched-card system is especially effective in constructing frequency distributions and correlation tables when the data are very numerous.

PART X

Applications of Specific Methods to the Solution of Statistical Problems

CHAPTER II

Uses of the Progressive Digit Method

By
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IN the Iowa State College Statistical Laboratory, for a number of years, the sums of squares and sums of products necessary for correlation analysis and curve fitting by the method of least squares were secured by the method of "Machine Factoring" described by A. E. Brandt (1928). This method, through the use of punched cards and tabulating machines, eliminates a great deal of labor and lessens greatly the chance of error, and to the satisfaction of many careful and conscientious research workers, preserves the arithmetic accuracy of the original observations. This method was a vast improvement over previous methods involving the use of hand operated calculating machines or coding and the various schemes of determining frequencies. It did, however, entail a certain amount of multiplication with a calculator.

In the Fall of 1929, the manager of the Des Moines office of the Tabulating Machine Division of the International Business Machines Corporation, suggested that the progressive totalling feature of the tabulating machines might be used and thereby eliminate the multiplication on a calculator. His suggestion was followed and a scheme developed but it was used to a limited extent only. It had several defects, the chief one being the use of a set of nine prepunched cards which was added so as to insure a card in each pocket of the sorter. Since these cards were punched, certain correction terms had to be subtracted from the results obtained from the tabulator in order to get the desired quantities.

In the summer of 1931, the present method was perfected and put into use. It has been used exclusively since that time. The method is so simple that any operator can be taught to use it with very little instruction. The necessary sums of squares and sums of products are secured from the tabulating machine tape by simple addition. Two good checks on the accuracy of results are provided.

The method and the technique involved can be explained at the same time by the use of illustrative examples. Four examples will be given showing its use in multiple correlation, analysis of variance, analysis of covariance, and curve fitting. Since the statistical laboratory is at present provided with eighty column equipment, the illustrations have been run on that type. The

	NUMBER OF SWINE	DAYS ON EXPERIMENT	POUNDS OF FEED PER 100 POUNDS GAIN	WEIGHT AT BIRTH (POUNDS)	FINAL WEIGHT (POUNDS)
		GRAND TOTALS			
	451	87270	192996	13405	106358
		PROGRESSIVE TOTALS			
FINAL WEIGHT — DIGITS					
9		4079	9813	697	5637
8		11060	25398	1799	13645
7		21516	48298	3356	26113
6		29195	64755	4547	35387
5		40463	89896	6333	49512
4		48599	108403	7672	60288
3		57244	128144	8956	70510
2		64113	142939	9973	78720
1		73333	163553	11357	90468
		87270	192996	13405	106358
90		60000	13214	910	6923
80		11790	25893	1715	13842
70		16860	37504	2539	20424
60		25370	55642	3713	30417
50		35530	78046	5317	43336
40		45070	99262	6813	55134
30		54238	120560	8339	67225
20		69830	155856	10777	86992
10		79340	176216	12197	97639
		87270	192996	13405	106358
300		9750	18133	1357	13548
200		72910	160831	11316	93675
100		86850	192115	13352	106218
		87270	192996	13405	106358
		349602	781204	54690	430300
		3440280	7621930	523200	4219320
		16951000	37107900	2602500	21344100
		20740882	45511034	3180390	25993720
WEIGHT AT BIRTH — DIGITS					
9		5501	11902	832	6821
8		17262	38254	2670	21446
7		26187	57350	3975	32491
6		32626	71515	4913	40190
5		41584	92802	6373	51477
4		48897	108319	7451	59980
3		58134	128365	8852	70538
2		65920	144980	10062	80257
1		73837	163145	11375	90270
		87270	192996	13405	106358
50		360	870	101	451
40		3660	9350	899	5126
30		45543	103345	8212	58131
20		83570	185727	13115	102626
10		87270	192996	13405	106358
		87270	192996	13405	106358
		369748	816632	56503	453470
		2204030	4922880	357320	2726920
		2573778	5739512	413823	3180390
POUNDS OF FEED PER 100 POUNDS GAIN					
9		6588	14087	940	7603
8		12236	26935	1858	14872
7		19796	44132	3026	24415
6		28674	62736	4334	35021
5		42634	94096	6433	51248
4		52278	114034	7839	62678
3		64145	138968	9537	77262
2		74407	162808	11231	89891
1		81020	179196	12344	98334
		87270	192996	13405	106358
90		8042	18307	1432	10962
80		15176	34712	2700	19882
70		26123	57920	4393	33035
60		30803	69836	5209	39469
50		36761	83251	6137	47086
40		47978	105109	7535	59189
30		57078	125141	8886	69222
20		72223	159776	11030	87579
10		79131	174554	12065	95787
		87270	192996	13405	106358
900		240	932	28	193
		240	932	28	193
700		540	1705	53	438
600		720	2386	93	686
500		5613	16145	920	6708
400		65641	145528	9544	76984
300		87270	192996	13405	106358
		87270	192996	13405	106358
		87270	192996	13405	106358
		87270	192996	13405	106358
		381778	836992	57542	461324
		3733150	8286060	593870	4622110
		33480400	74661600	5088100	40427600
		37595328	83784652	5739512	45511054
DAYS ON EXPERIMENT					
9		457	1199	85	685
8		1079	2804	211	1597
7		2041	5344	410	2975
6		2267	5773	440	3203
5		2867	7273	553	4107
4		3001	7650	592	4336
3		3194	8155	620	4562
2		3478	8904	679	5014
1		3780	9666	728	5463
		87270	192996	13405	106358
90		2973	5770	345	3311
80		47095	109076	7679	59812
70		47612	110336	7785	60509
60		48897	113461	8016	62397
50		52223	122603	8761	67459
40		74093	165001	11496	91403
30		77107	171947	11963	95177
20		78520	176030	12284	97187
10		81670	182812	12757	100739
		87270	192996	13405	106358
300		3000	4787	302	2523
200		32876	61899	3879	34409
100		87270	192996	13405	106358
		87270	192996	13405	106358
		22164	56768	4318	31942
		5101900	11570360	810860	6379940
		12314600	25968200	1758600	14329000
		17438664	37595328	2573778	20740882
	451	87270	192996	13405	106358

FIG. 243

Tabulator Tape (Progressive Digit Sheet) used in Multiple Correlation Example

symbols made familiar by Wallace* and Snedecor (1925, 1931)** will be used.

Example I—Multiple Correlation

The data for this example consist of observations on 451 swine used in type test studies by the Animal Husbandry Section of the Iowa Agricultural Experiment Station. Numerous measurements were taken at the beginning and end of the experimental period and at intervals of 60 days during that time. All of the pertinent information was punched on cards according to the form shown in Fig. 242. For this example but four of the variables were used; namely, days on experiment, total feed per hundred pounds gain, weight at birth and final weight.

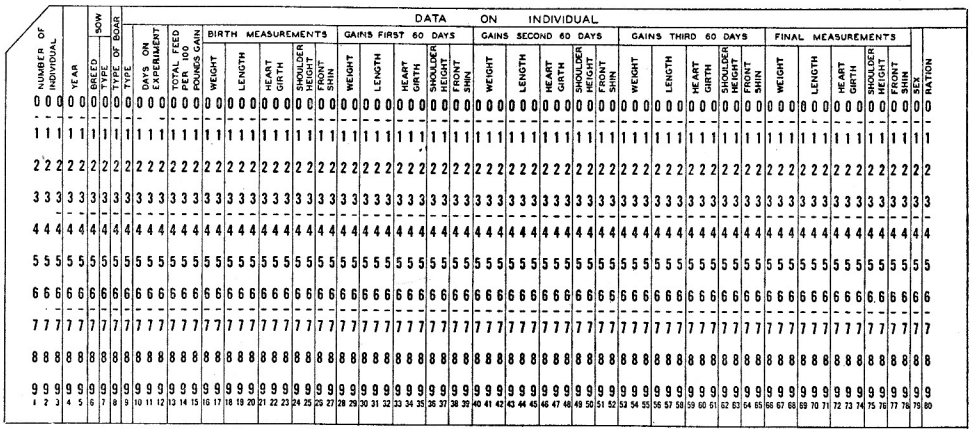

FIG. 242
Tabulating Card used in Multiple Correlation Example

The first step in multiple correlation analysis, following Wallace and Snedecor (1925, 1931), is the calculation of the simple correlation of each variable with every other and of the standard deviation of each variable. For these calculations it is necessary to have the sum of each variable, the sum of the squares of each and the sum of the product of each with each of the others. The sums of the variables are secured by direct tabulation but the sums of squares and of cross products are secured by progressive digiting.

In this laboratory it is customary to determine the grand total of each variable and of the card count at the beginning and, in the case of long runs, at the end of each run as a check on the accuracy of the machine work. The tape from the tabulator with headings and added notations is given in Fig. 243. The grand totals and progressive totals for each variable are printed in a given column which is properly labeled. The variables appear on the tape in the same order from left to right as they appear on the card, an arrangement that is not necessary but generally very convenient. The variable sorted on is indicated at the left of the sheet.

The grand totals were secured by ordinary tabulation. To secure the progressive totals the machine was plugged and the various switches set as shown

* Mr. Wallace is now Secretary of Agriculture in President Roosevelt's cabinet.
** Correlation and Machine Calculation, Iowa State College, Division of Industrial Science, Department of Mathematics.

9		5637
8	13645 - 5637 =	8008
7	26113 - 13645 =	12468
6	35387 - 26113 =	9274
5	49512 - 35387 =	14125
4	60288 - 49512 =	10776
3	70510 - 60288 =	10222
2	78720 - 70510 =	8210
1	90488 - 78720 =	11768
0	106358 - 90488 =	15870
		106358
90		6923
80	13842 - 6923 =	6919
70	20424 - 13842 =	6582
60	30417 - 20424 =	9993
50	43336 - 30417 =	12919
40	55134 - 43336 =	11798
30	67225 - 55134 =	12091
20	86992 - 67225 =	19767
10	97639 - 86992 =	10647
00	106358 - 97639 =	8719
		106358
300		13548
200	93675 - 13548 =	80127
100	106218 - 93675 =	12543
000	106358 - 106218 =	140
		106358

FIG. 244—Section of Proof Sheet used in checking the accuracy of the sums of squares which appear on the progressive digit sheet, Fig. 243.

in Fig. 245. The cards were sorted on column 68, that is, the units column of the right hand variable and removed from the sorter in the reverse of the usual order so as to present the cards bearing 9 in column 68 to the tabulator first, these bearing 8 second and so on. If any digits are missing as in column 13, hundreds column of pounds of feed per hundred pounds gain, blank cards are inserted for the missing digits so that the 9 total will be printed 9 times, the 7 total 7 times and so on. The cards are next sorted on column 67, removed in reverse order and tabulated. The control and indication plugging having been changed as indicated on the tabulator tape. This process is repeated until the cards have been sorted and progressively totaled on each column of each variable. A first check on accuracy is afforded at this point, for the last number in each group of progressive totals must be the same for an entire column and must equal the grand total for that variable.

The tabulating having been finished the next step is to add each group of progressive totals and then total these sums for each block after affixing one zero at the right of the sum for the tens digits, two for the hundreds digits and so on. The sums of products may be checked at this point. It is clearly evident that the sum of the products of final weight by days on experiment, block one column two, must be the same as the sum of the products of days on experiment by final weight, block four column five.

The check on the sums of squares is not so convenient. It is made by determining the totals, not progressive totals, for each digit and totaling. If this sum checks with the grand total for that variable the work is correct. Thus, the check of the accuracy of the values from which the sum of the squares of final weight, block one column five, is secured is as shown in Fig. 244.

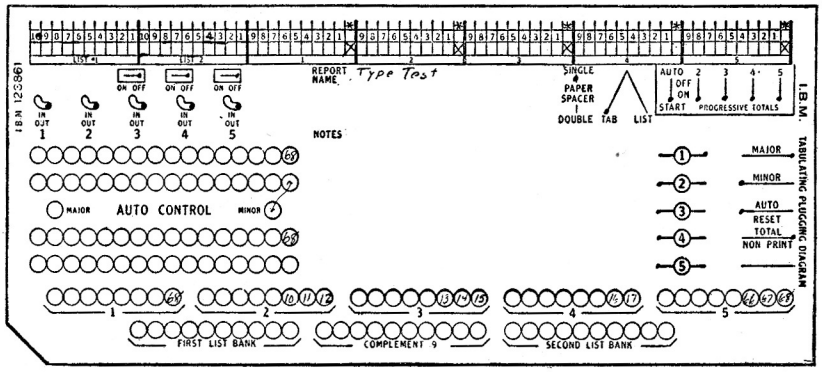

FIG. 245

Diagram showing wiring of tabulator plugboard for Multiple Correlation Example

n=451

		Days on Experiment	Pounds of Feed per 100 Pounds Gain	Birth Weight	Final Weight
		D	F	B	W
Sums		87270.000	192996.000	1340.500	106358.000
Means		193.503	427.929	2.972	235.827
D	1	17438664.000	37595328.000	257377.800	20740882.000
	2	16887032.991	37345362.887	259391.174	20580623.981
	3	551631.009	249965.113	—2013.374	160258.019
	4	742.719	812272.873	9212.762	709139.174
	5		.308	—.219	.226
F	1		83784652.000	573951.200	45511034.000
	2		82588585.284	573638.824	45513672.582
	3		1196066.716	312.376	—2638.582
	4		1093.648	13565.734	1044202.988
	5			.023	—.003
B	1			4138.230	318039.000
	2			3984.368	316127.883
	3			153.862	1911.117
	4			12.404	11843.303
	5				.161
W	1				25993720.000
	2				25082098.702
	3				911621.298
	4				954.789
	5				
δ's		35.012	51.555	.585	45.009

FIG. 246

Calculation of Correlation Coefficients

The simple correlation coefficients (r's) and standard deviations (δ's) are next calculated from these sums, sums of squares and sums of products as shown in Fig. 246. The numbers in bold face type are those secured from the tabulator tape, the other numbers being calculated from them. Detailed instructions for the calculations in this table are given with Table 7 in Wallace and Snedecor.

The multiple correlation coefficient and the standard regression coefficients can be found easily by following Table 8 and accompanying directions in the Wallace and Snedecor bulletin. Since the completion of this analysis in no way illustrates the method of progressive digiting, it will not be given.

Example II—Analysis of Variance

In examples II and III, results of testing* 1437 children at the Institute of Child Welfare at Berkeley, California, with the California Preschool Test, Schedule I, are used. These data were punched on cards of the form shown in Fig. 247. In this example only the information as to age groups, column 80, and the completions test scores, columns 52 and 53, are used.

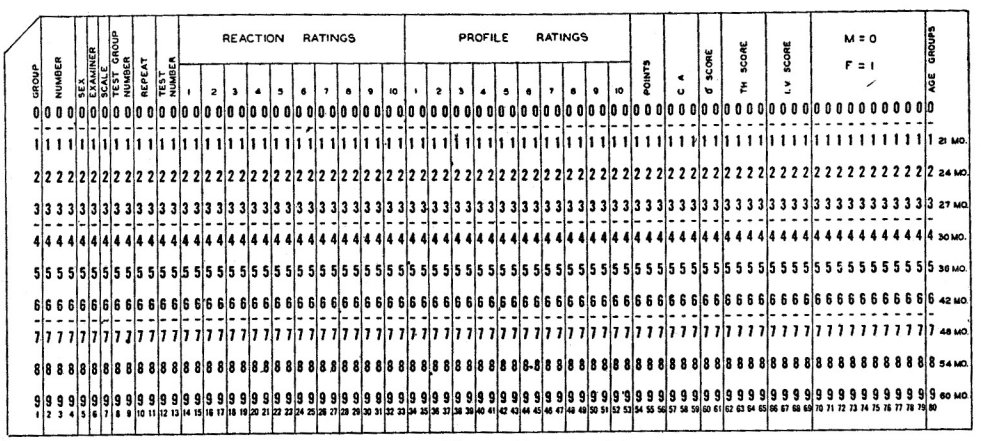

FIG. 247

Tabulating Card used in example on Analysis of Variance.

The method of Analysis of Variance is due to Dr. R. A. Fisher, the eminent British statistician, formerly of the Rothamsted Experiment Station, but now of the Francis Galton Laboratory of the University of London. Professor George W. Snedecor, Director of Statistical Laboratory, Iowa State College, presents in his book, "Calculation and Interpretation of Analysis of Variance and Covariance," twelve examples illustrating as many types of problem which may be critically analysed by this method.

For this example the type of problem illustrated in Snedecor's Example 2 is used, that is, a single criterion of classification and unequal numbers of observations in the classes. The criterion of classification in this case is age. To analyse this type of problem it is necessary to have the number in each class or group, the total of the variable under consideration for each class,

* These data were secured from Miss Gertrude Cox formerly with the Institute of Child Welfare but now Research Assistant in this laboratory.

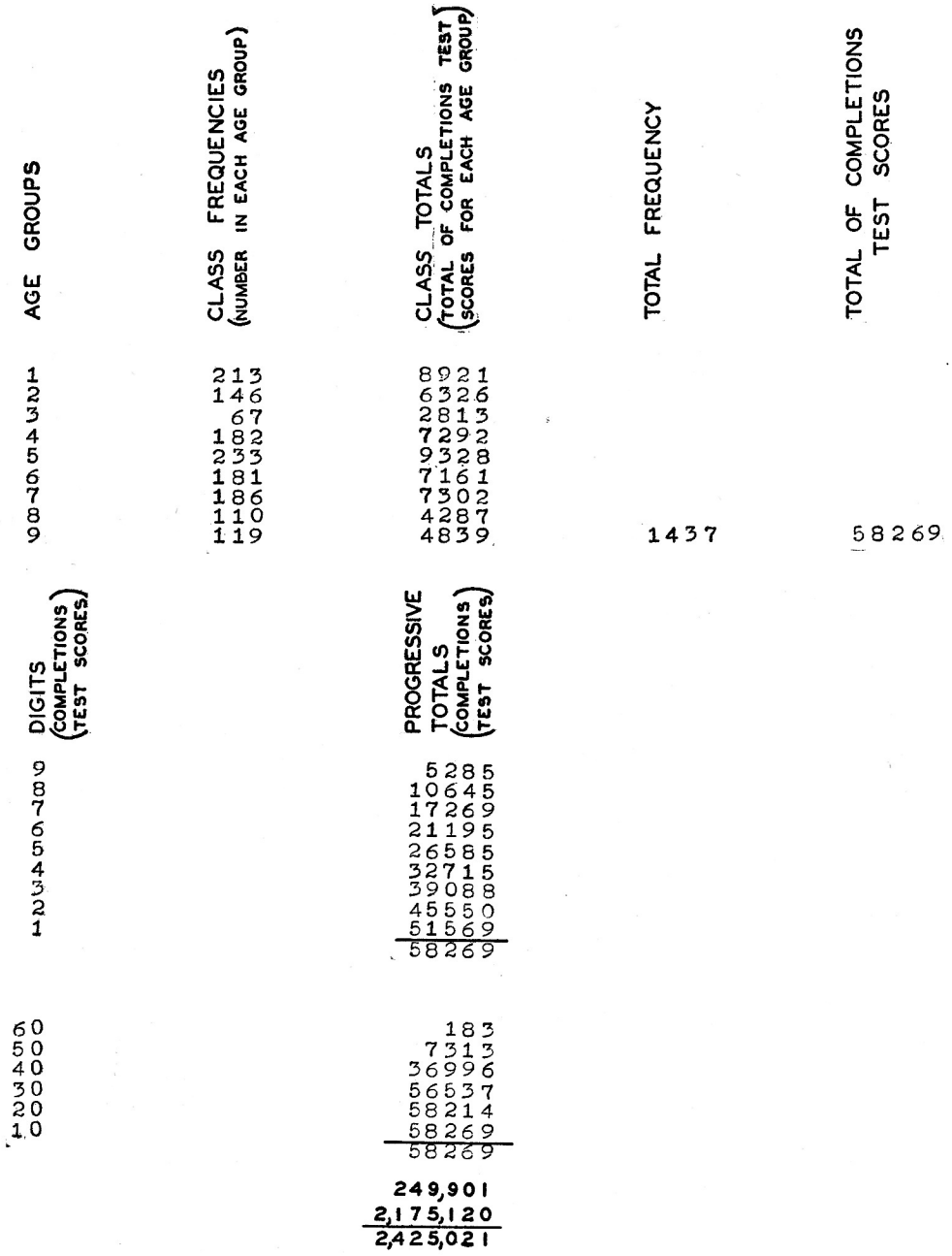

FIG. 248

Tabulator Tape (Progressive Digit Sheet) used in example on Analysis of Variance

the total number of individuals, the grand total of the variable, and the sum of the squares of the observations of the variable.

The tape from the tabulator is presented in Fig. 248. In order to secure the number of children in each age group, the sum of the completions test

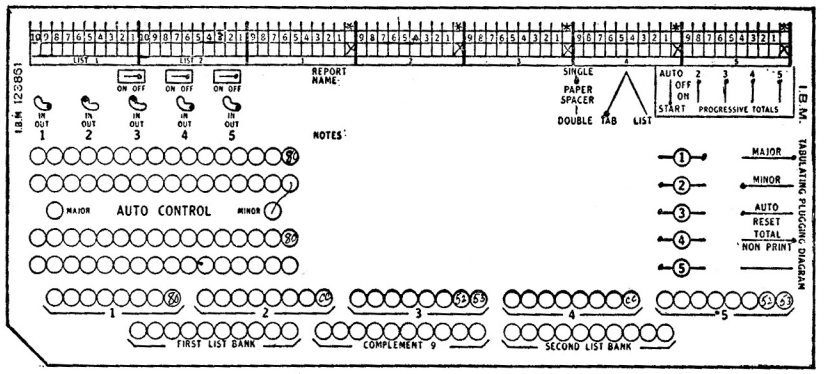

FIG. 249

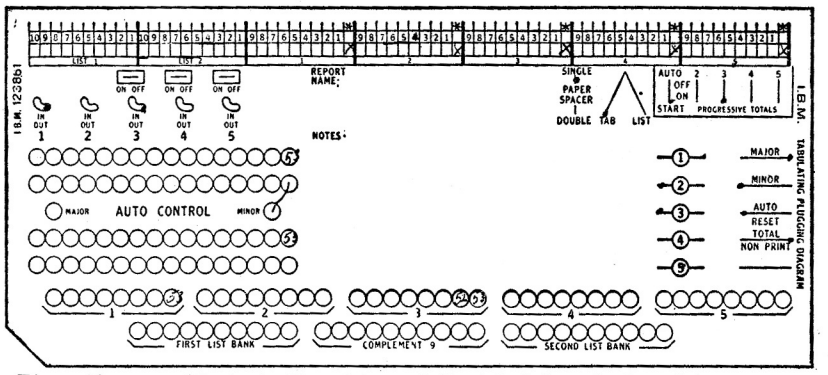

FIG. 250

These diagrams illustrate the wiring of the tabulator plugboard in connection with the example on Analysis of Variance.

scores for each age group, the total number of children and the total of the completions test scores for the entire group, as shown at the top of the tape, the cards were sorted on column 80, removed from the sorter in the usual order, that is, so that the 0's were presented to the tabulator first, the 1's second, the 2's third and so on, and tabulated. The plugging diagram is given in Fig. 249. Next on the tape are shown the necessary tabulations for securing the sum of the squares of the 1437 completions test scores. As indicated by the headings, the cards were sorted on the units column of the completions test score (column 53), removed in the reverse order and tabulated with the machine plugged as shown in Fig. 250. The cards were next sorted on the tens column (column 52), removed in the reverse order and tabulated, controlling on column 52 and listing the information in 52 in the second or tens position in counter 1. The simple addition indicated on the tape yields the sum of the squares of the 1437 observations.

In the analysis of variance it is necessary to calculate the sums of the squares of the deviations of sets of observed values from their means and from these values and the number of degrees of freedom* appropriate to them to calculate the mean square or variance attributable to each source of variation. The results of such calculations for the present example are given in Fig. 251.

* For a non-mathematical discussion of "degrees of freedom" see page 9 in Calculation and Interpretation of Analysis of Variance and Covariance by Snedecor, published by Collegiate Press, Iowa State College, Ames, Iowa.

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	1436	62267.7	43.36
Between means of age groups	8	2510.0	313.75
Within age groups	1428	59757.7	41.85

FIG. 251
Analysis of Variance of Completions Test Scores of children by age groups

To compute the three sums of squares given in the above table proceed as follows:

First, compute the correction term, thus

$(58269)^2 \div 1437 = 2362753.2$

Next, determine the total sum of squares, that is, the sum of the squares of the deviations of the 1437 observations from the mean of the entire group. By the method of progressive digiting, the sum of the squares of the 1437 observations was found to be **2425021**, as shown in Fig. 248. From this number and the correction term the desired quantity is determined, thus

2425021—2362753.2=62267.7

Then the sum of the squares of the deviations of the age group means from the mean of the entire group is calculated as follows:

$$\frac{(8921)^2}{213} + \frac{(6326)^2}{146} + \frac{(2813)^2}{67} + \frac{(7292)^2}{182} + \frac{(9328)^2}{233}$$

$$+ \frac{(7161)^2}{181} + \frac{(7302)^2}{186} + \frac{(4287)^2}{110} + \frac{(4839)^2}{119}$$

$$- 2362753.2 = 2510.0$$

Finally, the sum of squares within age groups is found by subtracting the between age group sum of squares from the total sum of squares, thus

62267.7—2510.0=59757.7

The mean square for each source of variation is found by dividing each sum of squares by its corresponding number of degrees of freedom, thus

62267.7÷1436= 43.36
2510.0÷ 8=313.75
59757.7÷1428= 41.85

In the above calculations the quantities taken directly from the tabulator sheet are in bold face type.

For a discussion and interpretation of the results given in Fig. 251, see Calculation and Interpretation of Analysis of Variance and Covariance by Snedecor, pages 14 to 20 inclusive.

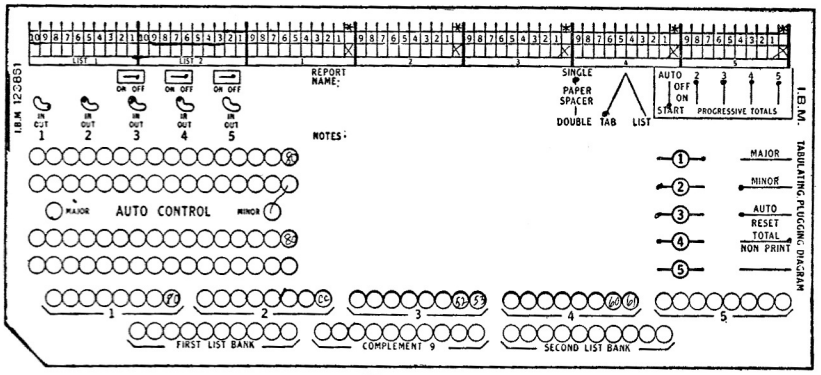

FIG. 252
Diagram showing the wiring of the tabulator plugboard for example on Analysis of Covariance

Example III—Analysis of Covariance

Snedecor's Example 10, TWO VARIATES, SINGLE CRITERION OF CLASSIFICATION, illustrates the type of problem which is used to explain the use of the tabulating machines in the analysis of covariance. The cards used for Example II were used again with another variable; δ scores, columns 60 and 61, Figure 247, being used. The criterion of classification, then, is age, column 80 and the variables are completions test scores, columns 52 and 53, and δ scores, columns 60 and 61. In principle the computation is the same as in Example II. In this case, however, there are two variables so that the same quantities must be calculated for each variable as were calculated for the one variable in the preceding example and in addition the sum of the products of the completions test score and the δ score for each of the 1437 individuals must be found.

The first step in securing the necessary quantities was to sort by age groups (column 80) and tabulate with the machine plugged as shown in Fig. 252. This tabulation appears at the top of the tabulator tape, Fig. 253. Then by the method of progressive digiting as explained in the two previous examples, the progressive totals necessary to obtain the two sums of squares and the sum of products were tabulated, Fig. 253.

For a problem of this type, three correction terms are needed, as follows:

for completions test scores,

$$(58269)^2 \div 1437 = 2362753.2;$$

for δ scores,

$$(70969)^2 \div 1437 = 3504940.1;$$

for products,

$$(58269)\ (70969) \div 1437 = 2877726.2.$$

The total sums of squares and products of deviations from means of the entire group are

for completions test scores,

$$2425021 - 2362753.2 = 62267.7;$$

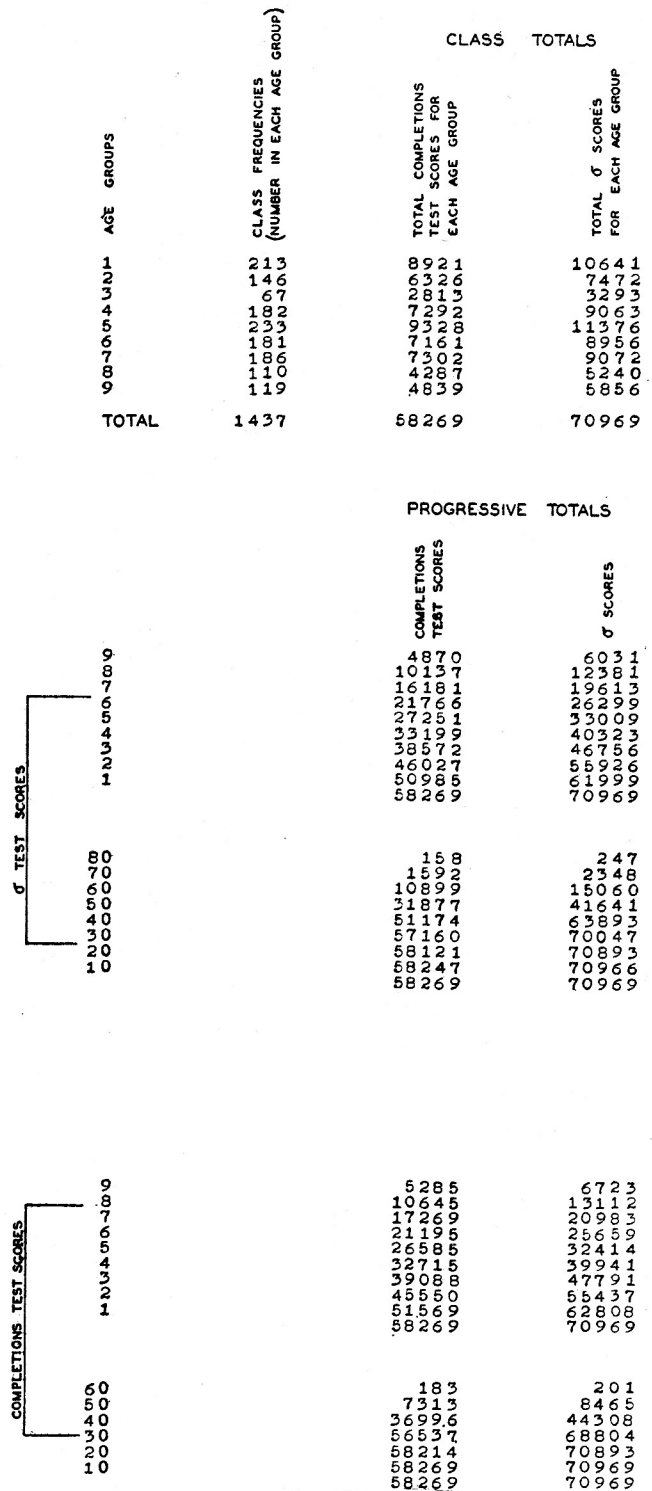

FIG. 253
Tabulator Tape (Progressive Digit Sheet) used in example on Analysis of Covariance

Source of variation	Degrees of freedom	Completions test scores		δ scores		Covariance		
		Sum of squares	Mean square	Sum of squares	Mean square	Sum of products	Correlation coefficient	Regression of δ scores on completions test scores
Total	1436	62267.7	43.36	148346.9	103.30	63541.8	.6611	1.0205
Between means of age groups	8	2510.0	313.75	1058.2	132.28	1329.3	.8156	.5296
Within age groups	1428	59757.7	41.85	147288.7	103.14	622125.0	.6631	1.0411

FIG. 254*

Analysis of Variance and Covariance, Completion Test scores and δ scores of 1437 children by age groups

for δ scores,

$$3653287.0 - 3504940.1 = 148346.9;$$

products,

$$2941268 - 2877726.2 = 63541.8$$

The sums of squares and products between means of age groups are for completions test scores,

$$\frac{(8921)^2}{213} + \frac{(6326)^2}{146} + \frac{(2813)^2}{67} + \frac{(7292)^2}{182} + \frac{(9328)^2}{233} + \frac{(7161)^2}{181}$$

$$+ \frac{(7302)^2}{186} + \frac{(4287)^2}{110} + \frac{(4839)^2}{119} - 2362753.2 = 2510.0;$$

for δ scores,

$$\frac{(10641)^2}{213} + \frac{(7472)^2}{146} + \frac{(3293)^2}{67} + \frac{(9063)^2}{182} + \frac{(11376)^2}{233} + \frac{(8956)^2}{181}$$

$$+ \frac{(9072)^2}{186} + \frac{(5240)^2}{110} + \frac{(5856)^2}{119} - 3504940.1 = 1058.2;$$

products,

$$\frac{(8921)\ (10641)}{213} + \frac{(6326)\ (7472)}{146} + \frac{(2813)\ (3293)}{67} + \frac{(7292)\ (9063)}{182}$$

$$+ \frac{(9328)\ (11376)}{233} + \frac{(7161)\ (8956)}{181} + \frac{(7302)\ (9072)}{186} + \frac{(4287)\ (5240)}{110}$$

$$+ \frac{(4839)\ (5856)}{119} - 2877726.2 = 1329.3$$

The quantities in the above computations which appear in bold face are taken directly from the tabulator tape. These results are entered in Fig. 254. The sums of squares and sum of products within age groups are secured by subtraction.

* For a discussion and interpretation of the results given in Fig. 254 see Calculation and Interpretation of Analysis of Variance and Covariance, by Snedecor, pages 70 and 71.

The mean squares are found by dividing the corresponding sum of squares by the appropriate number of degrees of freedom. To determine the correlation coefficients, divide a sum of products by the square root of the product of the corresponding sums of squares. Thus, for within age groups,

$$r = \frac{62212.5}{\sqrt{(59757.7)(147288.7)}}$$

$$= .6631$$

The regression coefficients are calculated by dividing a sum of products by the corresponding sum of squares of the independent variable. The coefficient of regression of δ score on completions test score for within age group is

$$b = \frac{62212.5}{59757.7}$$

$$= 1.0411.$$

Example IV—Curve Fitting by the Method of Least Squares

A problem which often arises in scientific or technical investigations is to determine the relation which exists between two quantities or variables. This involves the selection of a type of curve which will approximate the data and the determination of the constants or parameters of a curve of that type. If a polynomial of the form

$$y = a + bx + cx^2 + dx^3 + \cdots + kx^n$$

has been chosen to represent the relation between two quantities x and y, it is necessary to determine the degree needed and then to evaluate the constants a, b, etc.

To determine the degree equation that will approximate the data, a difference table may be set up. The values of the independent variable, x in this case, must be equidistant. Part A of the following table, Fig. 255, illustrates the point for a first degree or linear equation.

A

x	y	Δy
1	6	
		2
2	8	
		2
3	10	
		2
4	12	
		2
5	14	

B

x	y	Δy	$\Delta^2 y$
1	6		
		6	
2	12		4
		10	
3	22		4
		14	
4	36		4
		18	
5	54		

FIG. 255
Difference Tables

	X	Y	X^2	X^3
NUMBER OF OBSERVATIONS				
		GRAND TOTALS		
100	5050	849741	338350	25502500

PROGRESSIVE TOTALS

DIGITS

	X	Y	X^2	X^3
9	540	84695	37410	2911140
8	1010	169555	67750	5112620
7	1490	254680	99040	7406540
6	2000	340050	133300	9995300
5	2500	425441	166550	12482800
4	2990	510751	198810	14872040
3	3510	596016	234100	17565120
2	4040	681036	270440	20329640
1	4600	766551	299850	22477500
	5050	849741	338350	25502500
90	428	55254	30700	2530856
80	900	127300	63880	5142240
70	1703	246519	122625	9847511
60	2075	311512	146685	11616335
50	2503	380878	176225	13790071
40	2875	456736	198165	15338335
30	3303	528768	227825	17627511
20	3800	626373	255270	19455740
10	4128	697151	274750	20633346
	5050	849741	338350	25502500
900	416	78292	26302	1860560
800	725	143361	40875	2859397
700	1153	205600	70931	5077147
600	1762	314429	108374	7752922
500	2383	408687	154727	11463361
400	2740	474394	180328	13435665
300	3767	579446	221705	16484245
200	3637	613843	242643	18242493
100	4131	698839	274865	20631057
	5050	849741	338350	25502500
X^3 9000	358	66672	20086	1354882
8000	858	154243	55390	4023684
7000	1295	237921	82821	5943491
6000	1689	316857	108149	7699951
5000	2163	426861	133329	9133053
4000	2910	540663	157467	13431207
3000	3217	609632	215083	15515087
2000	3810	687824	247788	18020010
1000	4423	771274	294109	21836281
	5050	849741	338350	25502500
90000	212	61970	20802	1469316
80000	736	130068	52632	3982414
70000	1366	228442	100028	7754924
60000	1566	276975	110430	8314264
50000	2300	396123	164218	12523880
40000	2644	456210	186756	14187088
30000	3193	549010	226039	17103133
20000	3656	638980	253232	19037630
10000	4290	748216	292814	21324624
	5050	849741	338350	25502500
900000	294	6360	28814	2824164
800000	672	26749	64540	6201216
700000	1034	58604	97306	9167444
600000	1380	99730	127240	11757600
500000	1790	161080	160870	14614300
400000	2249	244524	196001	17207099
300000	2739	348404	230329	19613979
200000	3232	466636	261621	21574979
100000	3862	624519	294539	23333239
	5050	849741	338350	25502500
1000000	100	214	10000	1000000
	5050	849741	338350	25502500

	X	Y	X^2	X^3
9	1000	170390	66380	1987000
8	1000	170390	66580	4987000
7	1000	170390	66580	4987000
6	2000	341070	133100	9965000
5	2500	426461	166350	12482500
4	3500	596341	233030	17465500
3	3500	596341	233030	17465500
2	3500	596341	233030	17465500
1	4600	766551	300856	22477500
	5050	849741	338350	25502500
90	200	35735	12984	947600
80	800	143321	51800	3770000
70	1000	181760	64304	4615600
60	1600	286884	103680	7552000
50	1800	323364	116504	8476000
40	2400	427070	156040	11440000
30	2600	465600	169284	12407000
20	3700	663527	241730	17726900
10	3900	682863	255294	18899100
	5050	849741	338350	25502500
X^2 900	458	90302	29432	3053988
800	921	153875	64301	4917759
700	1446	254132	99008	7401395
600	2023	349054	138293	10398045
500	2327	402569	157549	11798279
400	2946	501837	200438	15113436
300	3751	663023	225241	16795053
200	3990	683297	259178	20206080
100	4748	746644	289600	21629584
	5050	849741	338350	25502500
9000	485	14978	47058	4556275
8000	945	49668	89385	8452475
7000	1464	111218	134296	12350304
6000	1747	187826	173195	15484491
5000	2465	270504	211556	18927275
4000	2934	303265	243006	20433244
3000	3465	522829	274398	23297275
2000	3960	647801	295980	23522400
1000	4454	765935	317934	24256484
	5050	849741	338350	25502500
10000	100	214	10000	1000000
	5050	849741	338350	25502500
Y 9	400	79332	24396	1659400
8	880	158836	59280	4356780
7	1285	220449	84901	6227065
6	1885	327551	124285	9214105
5	2265	403591	149481	10986225
4	3215	547673	216265	16253845
3	3635	602297	245461	18640505
2	4270	723403	286070	21611540
1	4720	795451	319466	24144680
	5050	849741	338350	25502500
90	770	108143	59158	4855730
80	1206	224178	89864	6783986
70	1831	325112	123197	9145651
60	2414	439517	159586	11839168
50	2814	499813	188690	13960854
40	3726	608366	216944	15720182
30	3720	644091	249804	18657618
20	3989	684139	269123	20198987
10	4490	744695	302837	22983611
	5050	849741	338350	25502500
900	872	161351	62446	4654328
800	1744	243034	94612	7069476
700	1824	333393	121948	8916846
600	2171	395378	145301	10642607
500	2723	488556	182661	13464893
400	3248	588651	214390	18456132
300	3528	639975	230996	16813062
200	4059	705764	271191	20192511
100	4576	784362	304068	22712884
	5050	849741	338350	25502500
9000	205	37815	12309	859663
8000	492	80367	32220	2433816
7000	682	110355	43770	3295396
6000	957	142927	63585	4959641
5000	1152	164829	74610	5849416
4000	2629	476388	174475	13276267
3000	3408	605799	227630	16807908
2000	4013	705662	267819	19848017
1000	4606	794058	307806	22983400
	5050	849741	338350	25502500
10000	3009	621850	201160	13281184
	5050	849741	338350	25502500
X 9	540	84695	37410	2911140
8	1070	169715	73750	5711660
7	1590	254980	109040	8404740
6	2100	340350	143300	10993500
5	2600	425741	176550	13481000
4	3090	511051	208810	15870040
3	3570	596176	240100	18164160
2	4040	681036	270440	20369640
1	4600	766551	299850	22477500
	5050	849741	338350	25502500
90	946	49668	89385	8432475
80	1790	161080	160870	14614900
70	2535	303468	216455	18670275
60	3180	452191	258140	21359600
50	3725	588499	287925	23001875
40	4170	699711	307810	23894100
30	4515	779189	319795	24513275
20	4760	826081	325880	24844400
10	4905	845809	328065	24500475
	5050	849741	338350	25502500
100	100	214	10000	1000000
	5050	849741	338350	25502500
100	5050	849741	338350	25502500

FIG. 256

Tabulator Tape (Progressive Digit Sheet) used in example on Curve Fitting by the Method of Least Squares

In part A of the foregoing table the first differences of y, Δy, are constant which indicates that these data can be represented by a first degree equation of the form $y=a+bx$. In this case but two constants, a and b, need to be determined. To find them by the method of least squares requires the simultaneous solution of the following two normal equations:

$$\Sigma y=na+b\Sigma x$$
$$\Sigma xy=a\Sigma x+b\Sigma x^2,$$

in which n is the number of observations and Σ indicates the sum of.

In part B of Fig. 255 the second difference of y, $\Delta^2 y$, are constant indicating that an equation of the form $y=a+bx+cx^2$ will represent the data. By the method of least squares the three constants a, b, and c are found by solving the three normal equations:

$$\Sigma y=na+b\Sigma x+c\Sigma x^2$$
$$\Sigma xy=a\Sigma x+b\Sigma x^2+c\Sigma x^3$$
$$\Sigma x^2y=a\Sigma x^2+b\Sigma x^3+c\Sigma x^4.$$

For this example, a set of data was made up such that the third differences would be approximately constant indicating that a third degree equation would represent the relation between the independent variable, x, and the dependent variable, y, that is, $y=a+bx+cx^2+dx^3$. The normal equations for determining the parameters a, b, c, and d by the method of least squares are:

$$\Sigma y=na+b\Sigma x+c\Sigma x^2+d\Sigma x^3$$
$$\Sigma xy=a\Sigma x+b\Sigma x^2+c\Sigma x^3+d\Sigma x^4$$
$$\Sigma x^2y=a\Sigma x^2+b\Sigma x^3+c\Sigma x^4+d\Sigma x^5$$
$$\Sigma x^3y=a\Sigma x^3+b\Sigma x^4+c\Sigma x^5+d\Sigma x^6$$

To solve these equations it is necessary to find the sums of the first, second, third, fourth, fifth and sixth powers of x (Σx, Σx^2, Σx^3, Σx^4, Σx^5, and Σx^6); the sum of the y's (Σy); and the sums of the products of y by the first power of x, of y by the second power of x and of y by the third power of x (Σxy, Σx^2y, and Σx^3y). By using the multiplying punch and the method of progressive digiting, these quantities are readily obtained.

The paired values of x and y were punched in the first two fields as shown in Fig. 257. Then, by plugging the field x both as multiplier and multiplicand, the cards may be run through a multiplying punch and the product x^2 be punched in the third field marked x^2 in Fig. 257. Then, by plugging the x field as one factor and the x^2 as the other, the cards may be run through the multiplying punch again and the product x^3 be punched in the fourth field. The cards are then ready to be tabulated by the progressive digiting method.

The tabulator tape is shown in Figure 256. The quantities used in this example are rather large and were so selected in order to give an adequate idea of the capacity of the machines. The columns were added as in the previous

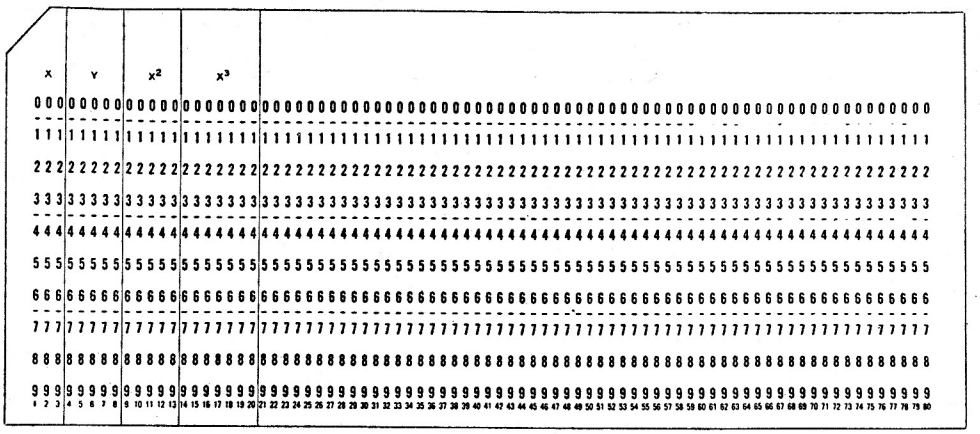

FIG. 257
Tabulating Card used in example on Curve Fitting by the Method of Least Squares

examples and the usual checks for accuracy applied. The necessary sums were found to be

$$\Sigma x = 5050$$
$$\Sigma x^2 = 338350$$
$$\Sigma x^3 = 25502500$$
$$\Sigma x^4 = 2050333330$$
$$\Sigma x^5 = 171708332500$$
$$\Sigma x^6 = 14790714119050$$
$$\Sigma y = 849741$$
$$\Sigma xy = 50907755$$
$$\Sigma x^2 y = 3396686895$$
$$\Sigma x^3 y = 242976478895$$

and n is 100. Substituting these values in the above four normal equations and solving yields the following approximate values for the constants

$$a = 91.67$$
$$b = 3.14$$
$$c = 9.952$$
$$d = -0.0997$$

The empirical equation which approximately represents the relation existing between y and x is

$$y = 92 + 3.1\,x + 10\,x^2 - 0.1\,x^3$$

No attempt has been made to present all the types of statistical problems in which the method of progressive digiting could be used. However, four rather general types have been presented and the persons who become familiar with the method through application to one or more of these four should be prepared to use it in the solution of other problems.

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